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The Propagation and Rearing of the Scallop, **Patinopecten yessoensis**, at Date

Date District Fisheries Improvement and Dissemination Officer Station

Akiharu ISHIHARA

1. Introduction

The yield of scallops in the Date region is only about 3% of the total yield in Hokkaido, but this region's name has been known for a long time, and similar to the southwest coast of Hokkaido, it is said to have been in operation in the early Meiji Era. With aid from the Hokkaido Government, at the Date Fishermen's Cooperative Association experiments have been carried out since 1954 to collect natural seedlings from the outer sea, and every year the number of cultivation beds for the seedlings were increased, and efforts were made to produce seedlings to maintain and breed the region's resources, as well as to carry out propagations along with cultivation experiments. Also, at the Usu Fishermen's Cooperative, from 1964 tests on the collecting of natural seedlings and their cultivation have been carried out, and during this period various tests and investigations were conducted on implementing the improved seedling collecting facilities, on efficiency testing, and on cultivation tests by releasing the transplanted seedlings; data obtained from these have been gathered together and are provided for reference.

2. The Appearance and Attachment of the Floating Larvae

At Date locations, although there is a dependence on water temperature, etc., the period in the average year when the floating larvae of the scallops are observed is about the 20 day period from the middle of June to early July, and aimed at this period the seedling collection facilities were set up by early June.

The fishing area where the seedling collection can be done is at the Date

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locations (points) which are all around the coastal fishing grounds, but similar results from these seedling collections cannot be obtained from each of these locations, and also depending on the year there are large differences in the depth of water at which the young scallops are attached.

Each year many young scallop shells are found attached to the middle to lower sections of stationary fence-like nets which are stationed at a water depth of 15-22 m. These young shellfish are very abundant, and although it is important to know their contribution to the fishing industry, it is basically unknown. In the 2 years of 1962 and 1963, for mid breeding the Date Fishermen's Cooperative collected several 10 thousand seedlings, but because of their coming off at the early stages, their number at the time of the attachment investigation is not the same as for those collected.

At the points of Date town, many young scallop shells can be seen even in shallow areas depending on the year. In 1961 there were cases where many young attached shells were observed near the roots of kelp, which had adhered onto concrete blocks (kelp reefs) put into 2-3 m deep water, and also observed were instances where 150-230 young attached shells were found on one cultivated kelp (total length 2-3 m). Up to the present time, the main location where the collection facilities were set up is the location with water depth 14.5-118.0 (18.0?) m, which is 700-1000 m from the Higashi Hama coast of the town of Date. Although no fundamental investigation for selecting this location was carried out (yearly), each year good collection results were obtained.

Although there are yearly variations, naturally occurring shells (some are recognized as 1 year old shells) can be seen at all the fishing grounds of the Date points. However, there are variations in quantity according to

the location, and the many confirmed fishing grounds are at a water depth of 15m - 18m, and as scallop fishing grounds they are rather deep coastal fishing grounds with quite muddy sea beds. The location where many natural occurring shells are found is the fishing grounds stretching east-west centered at North Mareppu, which is about the center of the Date points fishing grounds, but the density of the population and the area, etc., are not known. From Tanifujikawa point to Funaoka point follows this area and many (scallop shells) are observed. Shown in Table 1 are the results of the 1965 local collection condition survey using a tray collector-cultivator at 4 locations (Kogane, Mareppu, Funaoka, and Higashi-Homa points). p.3

During this investigation the highest number in one tray of 350 shells was observed at a water depth of 15m at the Mareppu coast. The water depth (facility water depth) was the greatest among the four locations, and at the other facility locations the water depths were those of the facilities originally used for seedling harvesting.

Based on this investigation, in 1966 there were 9 seedling harvesting facilities(3 film vertical types, and 6 tray type collector-rearing apparatuses) set up at Mareppu, and seedling rearings were carried out. The scallop attachment condition at Date shows that, although there are also vibrations from collector waves, etc., there is a trend to a lower number (of shells) at the upper-middle zone, with a greater number in the lower zone.

3. Seedling Collection Method and Results

The seedling collection method in 1954 used a landing net (fence-type stationary net with one net having a length of 90m, a net height of 15m, and a 30cm mesh), and this was done because young scallop shells had been found attached to the landing nets. In 1956 the scallop-shell vertical

system, which had been used at Lake Saroma, was tested with partial modification, and for the investigation on August 7 the seedling collection results at a water depth of about 1.8m for 1 empty shell (shell height about 10 cm) was an average 6.1 shells, at about 4.5m it was 121 shells, and at 6.0 m it was 12.5 shells, but there were many problems with the facility; in 1959 the cedar-leaf vertical system, which had been used in Okuriku Bay in Aomori Prefecture, was introduced for testing, and because the results (for collection) were favorable, this method was used continuously until 1963. Since then, after successfully collecting scallops using a synthetic resin, the cedar-leaf vertical system was no longer used, and the collections have been carried out by changing the collector to a synthetic resin (polyethylene film). p.9 The following year resulted in the development of the polyethylene tray-type collector-rearing equipment, which practically established the collection method, and at present the tray-type collector-rearing equipment is the main one being used. The transition in the collection methods and the collection results during the past 10 years are listed in Table 2.

Although the water depth (water depth at which the young shells are attached) for the seedling collection at Date has been partially described, let us examine it in a little bit more detail here. For 1963 up to 1966, the results of the attachment of the young shells at various water depths are shown in Tables 3-6, but it is a fact that at the time of the investigations the quantities and numbers were somewhat variable. The young scallop shells are attached at different water depths depending on the year. From the results of the past several years, the collection results are good for the years when many young shells are found attached in the lower zone. In cases where the attachment of the young shells in the lower zone are few in

number, the collection results for that year are not good.

When the attachment of the young shells are examined for the years 1963-1966 (refer to Figure 7), No. 4 has the pattern where the upper zone and lower zone have a smaller number attached, while the middle zone has a greater number, and this year was the worst collection year among the past 4 years. In the years 1963, 1964 and 1966 it is observed that the attachments increase from the upper to the lower zone, and the collection results were good. However, No. 1 shows the pattern where the lower zone has a large number of young shells attached, but even though many are attached in the lower zone, this does not mean a good collection is necessarily obtained. No. 2 and No. 3 show patterns where the young shell attachments increase from the upper zone to the lower zone, and the collections appear to be stable. Therefore, the selection of a location for an optimum collection is one which exhibits the pattern of No. 2 and No. 3. Polyethylene film and the tray-type collecting-rearing equipment have different styles (shapes?), and so naturally the numbers collected are different. Up to the present, the collection results are better using the tray-type collector-rearer than using film, but even using film the young scallop shell collections are good, and so it cannot be ignored.

However, when film is used, the young shells fall off early; when they p.20
reach a certain size they tend to fall off in a short period of time, and so one should be careful to not make a mistake on the collection time of the seedlings. The film was placed in baskets (35 X 35 cm frame of coating wire with a cross in the center, which is wrapped with a 4 X 6 mm mesh net), and the collections of scallops were tested at Usu (put in place on June 25, 1966 at a location 1,200 m from the shore and at a water depth of 18 m at South

Usu, Date); the test results are shown in Table 7, but the collection of scallops using film needs future improvements, and one idea is to refer to the previously described method.

Test Results of Collections using Baskets containing Film p.21

For each basket, 2, 3 or 4 films (black in color, 0.07 mm thick, 15 X 40 cm) were tied to the string hanging from the basket, and 20 baskets were connected together (Figure 8, third figure), and then placed in water at a depth of more than 8 m and at 6.5 m intervals. They were put in place on June 25, 1966. On August 9 the baskets with 3 films were taken out, and examination showed that the younger shells were found on the lower baskets; the 16th basket had the highest number of 520 shells attached, and a water depth of 13-14 m gave the largest number attached. Those that had more than 400 young shells attached per basket were the 8 baskets including the 8th and 14th and below, and those that had more than 300 young shells attached per basket were below a water depth of 10 m, while the 3 baskets in the upper zone had 50-100 attached.

The young shells were attached to both the nets and the films, and in the upper zone more young shells were attached to the films, while in the lower zone the numbers attached to the nets and to the films were almost equal. Of the 5 baskets in the upper zone, 74% of the young shells were attached to the films and 26% were attached to the nets, while for the 15 baskets in the lower zone 48% were attached to the films and 52% attached to the nets. The overall ratio for the baskets is 50.6% attached to the films and 49.4% attached to the nets, and the longest shell length is 12 mm while the shortest is 2mm, giving quite a scattered range, but most of the young shells are 8-5 mm in length. The collection results using different numbers of films show

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no differences due to different water depths, etc.

Using this method the young shells attached to the nets appear to be a problem, but needless to say it will be addressed later.

With Regard to the Tray-Type Collecting-Rearing Equipment p.22

In 1966, for putting the tray-type collecting-rearing equipment in place, the test was carried out using it wrapped with a net (Russell net, 4 X 3 mm mesh), but the attachment of the young shells on the collector is found to be unsatisfactory. This is considered to be related to the eddying currents caused by the current beating against the trays, but it appears that the net also affects it considerably. According to the collection results for 2 years, the lower zone results are better, and so the plan should be to focus on the lower zone with the vertical set up. However, if this method is to be utilized, adequate manual control operations must be performed. That is, the collected numbers are balanced, the predators (starfish, etc.) are removed, one wraps with nets (Russell net) to prevent the young shells from "falling out" due to the vibrations of the trays caused by the waves, etc.

5. Attached Young Shells and Growth

For the young scallop shells which attach themselves to the collector, depending on the conditions for that year such as water temperature, the appearance of the floating larvae, the currents, etc., the numbers that are attached and the attachment conditions at the water depths can be considered to be different. The collectors which have a large number attached in the lower zone, have large and small young attached shells all mixed together. This appears to be related to the egg release. Since scallops are dioecious, when the gonads mature, in the female they are pink to red, while in the male they are milky white, and the number of eggs from 1 mother shell is about

8.000-18.000 X 10^4, while the sperm number is said to reach 3.700-8.900 X 10^8. Scallops spawn not only 1 time but are said to spawn several times, and because, as seen at Lake Saroma the second spawning produces more than half the number from the total spawnings, the collection is focussed on this second spawning. Also at Date the numbers from the second spawning appear to be larger. That is, for the observations of July 25, 1966 on a 15 X 12 cm film from a water depth of 14.5 m, it can be surmised that this is so as shown in Photograph 5 where it is divided into 3 sections according to the differences in the shell lengths, large and small.

Although it differs according to the ocean conditions for that year, the young shells attached to the polyethylene film grow in July to an average shell length of 3.87 mm, and in August to an average shell length of 7.87 mm. For the growth after the above, because the attached shells are collected each year from the films so that they can be used as seedlings for the mid-rearings at the end of August, it was confirmed that the shell length was 22 mm on October 9, although this is in the attached form, and since for those that have grown to a shell length of 22 mm there are a lot of losses of the young shells from the time of attachment (investigated on the collections results on September 3), the seedling collections for the mid-rearings are better done by the end of August while the shell length is still about 10 mm.

6. Mid-Rearing p.23

At Date, one of the scallop propagation methods, the transplanting and releasing of the seedlings was carried out using the seedlings (of unknown sizes) produced at Lake Saroma , and transported by train in the early Showa Period. After that, in mid April of 1958 45 tons of young shells produced at Rikuo-Bay were transported by sea to Date, and they were released at the

town of Date areas at a water depth of 12-13 m at the Kogane, Kitakogane and Nishihama coasts, and at a water depth of 12-14 m at the Kogane-Nishihama coast; and there are results that show that about 95% of the released numbers were recaptured after 5 years of operation. Based on this, the importance of releasing healthy reared seedling shells was recognized, and in 1963 the mid-rearing method was brought in from Rikuo Bay and tests were conducted. The seedlings were collected with a cedar-leaf vertical-type collector (collected on August 25), and the rearing was first done in a box-type apparatus (using 6 mm diameter iron boat (bolt?), a 30 X 30 X 15 cm frame was made and then covered with an Amiran net), and then depending on the growth level, they were transferred to an andon (covered lamp stand) type apparatus (using a 4.5 mm diameter iron boat, a 50 cm diameter ring with a welded cross piece was made, then covered with a 14 knot nylon net, and 10 of the rings were stacked together with 20 cm spacings) where rearing was carried out. During growth there was little fighting and few deaths, and the results are as shown in Table 9.

When the young shells were taken out of the collector and the mid-rearing was carried out, there was an "unevenness" in the growth of the collected shells. This appears to be due to the collection density. For the mid-rearings which were continued for several years, young shells which have less than 15 mm in shell length were observed in the middle of October, and also at the release times (December-February) there were immature shells which had less than 20 mm shell lengths. These young shells belong to the group where growth has been totally stunted. When the ratio of shells with slow growth is examined with respect to the overall number of reared shells, there is a relationship to the number of shells collected in the rearing equipment for that year, and it was 6% in 1964, 14% in 1965, and in 1966 the number collected

p.24

was smaller and so the slow growth ratio was zero (growth was good as well).

The results from the past 3 years for growth during the mid-rearing using the tray-type collector-rearer show that in the middle of October for the longest shell length of 36 mm, a shell height of 6 mm and a shell width of 9 mm, the weight is 5 g, and for the shortest shell length of 26 mm, a shell height of 27 mm, and a shell width 6 mm, the weight is 22g, and so the requirements for releasing the shells are met.

Beside the collection density, an item that should be noted during the mid-rearing stage is the incursion of starfish into the rearing equipment. In the case of the box-type rearing apparatus, many of these are caused by human factors such as the starfish being mistakenly collected when the young shells are collected, and in the case of the tray-type collector-rearer or the baskets containing film, they can be considered to have come in as larvae. Once the starfish are inside the rearing apparatus they cannot attack the shells until their arms reach about 8 mm in size, but when they grow more than this they begin attacking the shells and can eat up entire young shells inside the rearing apparatus. (Observations of October 8,1963: the arm of the starfish was 38 mm, the longest empty shell length was 25 mm, the shortest shell length was 6 mm, the ratio was 6 to 4, the number of young shells was 132, for the box-type rearing apparatus). (Observations of September 23, 1965: for the tray-type collector-rearer, the arm size of the starfish was 25 mm, the empty shell length was 22 mm, and there were 95 shells). The damage caused by starfish occurs when the box-type and the tray-type equipment are used, but there is no damage when the andon (cylindrical) type is used because they are transferred.

For carrying out the mid-rearing using the basket-type rearing apparatus, a slightly larger number (up to 200) is collected in the box type, and when

they grow to a size at which they do not fall out of the andon (cylindrical) type net, the container is quickly changed. The appropriate number is inferred from the several years of results obtained here, and if they are allowed to grow properly until the release time (to an average shell length of 30 mm), using the present andon (cylindrical) type rearing apparatus (diameter 50 cm), the most appropriate condition appears to be 130-140 shells per layer.

7. Released Shells p.26

When young shells which are being mid-reared grow to an average shell length of 30 mm, they must be released. If they are carelessly allowed to grow for a longer period of time, in the rearing apparatus (particularly, when using the box-type rearer), the growth of smaller young shells stops, while the young shells which had reached a certain growth level keep growing very well. Thus, according to the sizes of the young shells in the container, an "uneven" growth occurs. When released under these conditions, after the release the smaller-sized young shells show quite a small survival ratio (until they grow to collection-size shells), and errors occur when the propagation efficiency is calculated from the number of released shells, and also a negative aspect is created in the propagation planning.

As the released shells, healthy normally grown shells are desirable, and even though partially deformed grown shells are not preferred (for the 1965 grown shells the opening-closing sections of the left-right shell was 2 mm for shells with shell lengths of 25 mm), sometimes it is convenient at the time of reinvestigations if impediment rings (Photograph 21) are present, especially on the left-right shell. Although the sizes of young shells released at Date differed according to the year, the three year averages give a shell length of 35.5 mm, a shell height of 37.8 mm, a shell width of 9.6 mm and a

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weight of 6.1 g.

8. Date Area Scallop-Shell Distribution and the Fishing Grounds

The scallop fishing grounds at Date are found at a water depth of about 9 m to about 21 m, and at Kogane, the eastern part of the fishing grounds, the width from the shallow sea to the deep sea is small and it becomes wider at the center section and extends to Chowa; between the Choryu River and the Entomo point there is a scallop-inhabited fishing grounds, although this area is small. The length of the fishing grounds is a long belt about 11 Km in length, and the area is estimated to be about 10.000 Km^2. The water depth gradually becomes deeper going out towards the sea, and the sea bottom is flat and gently sloping, but at Kogane the sea bottom is sharply sloped, and at the eastern side of the Choryu River the water depth varies.

On the shore side, the sea bottoms of the fishing grounds have a small amount of rocks containing coarse sand, and there are only a few scallops found here; this is a fishing ground for white shellfish.

In these scallops the right shell is milky white, and many are 4-5 years old with a few young ones. The fishing grounds where many scallops are found have a water depth of 13.0-15.5 m, and the sea bottom is generally called "gravel ground" and "shell ground."

The fishing grounds (sea bottom) generally called "gravel ground" and "shell ground" indicates that there is a lot of gravel and shells, and the "gravel ground" and "shell ground" at Date are thin layers, unlike the thick ones found at Monbetsu or Tokoro (Photograph 12). p.28

At a water depth of greater than 16 m the scallop population becomes extremely small, Hidaberi Inginchaku (type of sea anemone?) are attached to the scallops and stones, and the sea bottom is muddy.

In the last 1-2 years, from Mareppu to the Funaoka coast at a water depth of 3 1-3 4 m , although they were small in number, using a "plaice gill net" 4-5 year old scallops (right shell is pale in color or milky yellow) were caught.

This sea bottom is presumed to be "gravel ground" and not muddy, and further investigations are necessary. (The actual state of the scallop resources in Date will be reported at a later occasion).

9. Seedling Release and Propagation Efficiency

As one of the trials to study the propagation efficiency of the transplant-release process, the seedlings of young scallop shells which were mid-reared in a certain sea region were released and tests were carried out on the growth, movements, deaths, etc., and the results will be described here. The seedlings used for the transplant-release process were the young shells naturally collected at Higashi-hama in the town of Date in 1964 and then mid-reared (during the period of August 25, 1964 - January 12, 1965).

The size of the released seedlings had an average shell length of 34 mm, a shell height of 39 mm, a shell width of 9 mm, and a weight of 4.2 g, and they were released on January 12, 1965. The number of releases shells was 32,500.

(1) Fishing Grounds and Release Method

The fishing grounds is an area where fishing has been prohibited since early October of 1964, and it was set up 500 m along the coast of Naka Mareppu in Date and 2,000 m outward in the ocean. (The scallop habitat in this sea region is 400-1,000 m out in the ocean at a water depth up to 21 m, and 2-year old shells are found there, but their numbers or their age classifications could not be determined). The sea bottom up to a water depth

of 9.5-12.0 m (400-600 m out in the ocean) is a flat sandy area with no bumpiness, although there are some small bumpy areas, with small amounts of rocks and gravel; the area with a water depth of 12-16 m (600-900 m out in the ocean) has a flat sandy sea bottom with gravel and empty shells of bivalves (Ezoabura-gai, Ezowasure-gai*, Uchimurasaki**, Uba-gai***, Mate-gai, Tsumeto-gai, Ezokinchaku-gai****, etc.), and so the region below a water depth of 16 m has a sea bottom similar to the above but with a thin layer of mud covering it. The release of the seedlings was carried out along the coast at a water depth of 12.5-15.0 m. (The actual release area is 400m X 100m).

* Callista (Ezocallista) brevisiphonata CARPENTER *** Spisula (Pseudocardium) sachalinensis SCHRENCK
** Saxidomus purpuratus SOWERBY **** Solen strictus GOULD
***** Chlamys (Swiftopecten) swifti BERNARDI

The investigations and observations were carried out 2 times, i.e., p.30 on September 22, 1965 and on September 13, 1966; and the 2 methods used to carry these out were by using beam nets (beam length of 185 m, 40 cm long claws, 13 beams, kaijiki length of 1 m, net-bag mesh of 90 mm) and by scuba diving. Two beam nets were used, and these were operated manually, with the speed at the bottom of the sea being 6 minutes -6 minutes 30 seconds per 100m; one beam net covered an area of 16 Km^2. Also, for the scuba diving, the investigated area was set up with ropes to be 120 m^2 and 300 m^2, and all the scallops in these areas were collected by the tsubo ($= 3.30\ m^2$) gathering technique. Also by means of scuba diving, the scallop habitats were observed and recorded by photography.

(2) Test Results

About 8 months after the release of the seedlings, by scuba diving and collecting with the beam nets, the habitats were investigated, and the results from the scuba diving operations are shown in Table 11.

The released shells were found in an average density of 0.193 shells (the average of 3 locations) per 1 m^2, and they were found at a water depth

of 14.5 - 13.0 m scattered in all parts of the fishing grounds. However, among the habitat conditions, several habitats were observed (about 6-7 shells per 3.3 m^2) with a high-density distribution. For the growth of the released shells, the averages were that the shell length grew from 34 mm to 86 mm, the shell height from 39 mm to 84 mm, the shell width from 9 mm to 23 mm, and the weight increased from 4.2 g to 8 g.

With regard to the habitation conditions observed, all the shells had their right shells buried in the sea bottom, and their backs were covered with fine sand.

In the report by TANAKA (1962) on the ecological observations of first year seedlings in the natural environment, the first year shellfish live attached to the sea bed at the sea bottom and covered with a thin layer of sand, and they live mainly assembled together; after one year the measured level of scattering shows that they spread out radially along the contour lines with a long diameter of 150 m and a short diameter of 100 m, with the density getting lower when moving away from the center, and most of the young shells are said to have a sedentary life style; and it is inferred in the observations here that a similar tendency is seen. As a result of the observations on the released shells, although the biological conditions cannot be clarified, it was recognized than many localized movements occur during a short period of time. This was deduced because of the many holes near the released shells. These holes were exactly the same as the ones obtained when the released shells were removed.

The investigations with the beam nets were carried out at 6 locations along the coast at a water depth of 12.0m to 16.0 m. The results obtained are shown in Table 12.

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The inferences on the survival ratios were made with reference to the beam net results, and based on the results of the scuba diving operations. When calculated on the basis of the inhabited areas at a water depth of 13.0-14.5 m, in a 125K m^2 (500 m X 250 m) area the population number is 24,115 and the survival ratio is 74.2%.

One year and 8 months after the release, the second investigation was carried out only by scuba diving, and the method was the same, but collection of the scallops was carried out at one location of 300 m^2. The growth of the released shells showed a rapid growth, and their average measurements are as shown in Table 13.

When these growths are examined, after 2 years and 2 months the shell conditions are all satisfactory for harvesting (according to the Hokkaido Fishing Regulations, for a shell length of less than 8.2 cm; and according to the Date Fishing Coop, the self-imposed regulation is a shell length of less than 12 cm).

In the second investigation, because the scallop shells were collected at only one location, the survival ratio from the one-year old to the two-year old shells could not be accurately ascertained, but for the investigation at the same water depth and location, a larger population number was found in the second investigation results than in the first investigation results (shells collected by scuba diving).

From this it can be inferred that the survival ratio is better in going p.32
from the one-year old shell to the two-year old shell than in going from the zero-year old shell to the one-year old shell. For the period of going from the one-year old shells to the two-year old shells, in order to determine the survival ratio and the propagation efficiency of the seedling releases, investi-

gations were carried out on the released shells which were collected at the fishing-prohibited area and at the eastern and western sides of this area. The results from this are shown in Table 15.

From these results an accurate survival ratio in going from the one-year old shells to the two-year old shells could not be obtained, but the effects of the released shells on the fishing industry, that is, the propagation efficiency of the seedling releases, were almost clarified. The number of recaptured shells was confirmed to be 73.42% according to the fishing yield investigation, and the fishing yield was 7,913.2 Kg. Monetarily the yield is about 1,620,000 yen. With regard to the survival ratio of the released shells, an accurate number cannot be obtained until a future survival investigation is carried out.

Next, when the migration conditions of the released shells are examined, shells which grew to an average shell length of 13.45 cm were found on September 1966 at the eastern and the western fishing grounds which were outside the boundary of the area where fishing was prohibited. (Investigation results -- at the time of the resource investigation on September 7, 1966, using 2 beam nets about 100 m from the eastern boundary, at a water depth of 13.0 m, released shells numbering 31 were collected. At a location about 100 m from the western boundary and at a water depth of 13.0 m, 6 released scallops were caught.) Although it is not known if all the released shells show a migratory tendency, or if they migrate during the growing process or if the migration is related to the currents, but many are found to have migrated to the eastern fishing grounds. Those which migrated to the western fishing grounds were small in number. Also, the released shells that migrated from the boundary of the fishing-prohibited area may have been those shells which were living near

the boundary of the fishing-prohibited area and migrated temporarily at one stage in their growth, but in the results of the fishing yield investigation the fishing yield from the fishing-prohibited area was about 80% (versus the number of shells) of the yield of the released shells, and so no large migration can be seen.

When the living released shells which had moved out of the fishing-prohibited area were observed, more of the released shells lived within 100 m from the boundary on the eastern side of the fishing grounds, and migrations occurred up to about 200 m from the boundary of the fishing grounds, and then the migrations gradually decreased. Also, the migrations occurred along the contour line with the same type of sea bottom.

The maximum migration point in the western fishing grounds was about 100 m from the boundary, and although the density was high near the boundary, it was only 1/5 of that on the eastern side. As shown in Photograph 17, the sea bottom of the fishing-prohibited area after 1 year and 8 months following the release became completely muddy, and due to the opening and closing movements of the scallops, some parts of it became as shown in Photograph 18.

Around where the released shells lived, there were no holes observed like p.33 the ones observed before; they were buried with their backs covered with sand and most of them had their backs parallel to the sea bottom. Among the scallops' migration circumstances (partial), in order to observe whether the migration occurs as an escape from enemies (starfish, etc.) and/or as a sensory response to approaching enemies, the scallops were stimulated manually and the circumstances of their escapes were observed. The method was carried out by using starfish to poke the scallops, and this was done on about 50 shells (30 released shells, 20 shells which were over 3 years old); among these only 3

released shells jumped about 15 cm in height and landed about 50 cm away, while the others just closed their shells.

Although it is only one test, it was inferred from these observations that the younger the shell the more they take evasive action. However, whether the evasive action has any relationship to the migration of the scallops cannot be determined unless future observations are made, but it can be inferred that the local migrations do not take place to evade enemies. Compared to the starfish habitation situation observed at the time of the seedling release in the fishing grounds, after one year and 8 months an increase in the habitation of starfish was observed, in particular, the habitation of the Itomaki starfish was found to have increased.

10. The Rearing Experiments

The scallop rearing test in the Date area was carried out by the Date Fishermen's Cooperative in order to do basic rearing research and for establishing commercialization, and it began on a small scale in 1963 using the vertical-type ear-shaped hole-digging apparatus, which had been used at Yamada Bay in Iwate Prefecture.

The test results showed that there were faults in the vertical method, the growth was slow, there were many attached sundry things (kelp, hard-shelled mussels, barnacles, etc.), and there were also problems in managing the procedures, and so the conclusion was reached that there was little commercialization possibility from this; as a result improvements of the facilities were necessary.

The following year, based on these data, various studies were carried out and the resulting plan was to place the shells in a net and subject them to vertical rearing; the experiments were carried out from 1964 to 1966 focussing

on the following aims.

1. Establishment of rearing for commercialization.

2. Investigation of the 3-dimensional use of the rearing fishing grounds.

3. Growth comparisons with the seedling-released shells.

The rearing test method used natural young shells at Date in 1964, and it was a 3-stage procedure. That is, in the first stage healthy seedling shells are reared by the mid-rearing procedure, the second stage rears the seedlings for use in growth, and the third stage is the actual growing period.

(1) Rearing of healthy seedling shells

The rearing of healthy seedling shells was carried out so that mid-rearing would result in achieving the final growth target where the average shell length is 40 mm. The rearing method (Figure 9) and the rearing equipment have already been described in the mid-rearing section, and so they will not be described here.

The details of the procedure carried out by the Date Fishermen's Cooperative were as follows: 70-100 shells per layer were placed in an andon (cylindrical) rearing apparatus, then reared until March 18, 1965 to an average shell length of 45.5 mm. Also, the Usu Fishermen's Cooperative used 100 shells per layer in an andon (cylindrical) rearing apparatus and they were reared until March 14, 1965. (Average shell length of the reared shells is unknown). The locations where the vertical rearings were carried out were at a water depth of 6 m in Usu Bay for both of the Fishermen's Cooperative groups.

(2) Rearing of the seedlings for growth p.34

The rearing methods were of the vertical type, but different rearing equipment was used at the Date and the Usu Fishermen's Cooperatives, respec-

tively. At the Date Fishermen's Cooperative, a multi-layered rearing apparatus (using polyethylene rod of 9 mm diameter, 38 cm diameter rings were made, then an iron cross was tied on each and wrapped with a polyethylene monofilament net which has no knots and is milky white in color and 27 mm mesh; and 40 of these baskets were connected together) was used for carrying out the procedure. In order to observe the effects of storage density on the growth, 4 storage densities (10, 15, 20 and 25 shells per layer) were used, and for about 6 months from March 18, 1965 to September 25, 1965 at about 1000 m offshore at Higashi-hama, Date, the 4 rearing apparatuses were vertically lowered to a water depth of 17 m. The growth investigations were carried out 3 times, and the growth results shown in Table 16 were obtained.

For the higher storage densities there was less growth, while for the lower storage densities there was better growth. When the growth for the storage numbers 10 and 20 shells per layer are compared, with reference to those for a storage density of 10, the storage density of 20 shells had shell length growth differences of 32% in June, 14% in August, and 20% in September, while for the weight differences they were 34% in June, 50% in August, and 25% in September. Depending on the storage density, growth variations can be seen in the reared shells: for the September observations, the shells in the 10-shell storage group showed normal growth, but the shells in the 20-shell storage group showed 15% abnormalities in one rearing apparatus. However, the extreme growth 'disparities' (the phenomenon which occurred in 1 box in the box-type rearing apparatus, or in one layer in the andon (cylindrical) rearing apparatus), which were found in the mid-rearing test (1963), did not occur here.

The rearing apparatuses of the multi-layered type were lowered vertically

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to a water depth of 5 m to 10 m from the sea surface, and for the growth, regardless of the storage density, at a water depth of 8-12 m an even growth was observed. When these evenly grown shells were compared to the upper-layer reared shells, there were growth differences of about 8% in the shell lengths and weights, while comparison to the lower layer showed growth differences of about 12%. From approximately midway through the rearing period (after the middle of July), diatom attachments were observed on the upper to middle layers of the rearing apparatus, but few remained adhered. All of the reared shells had Ooiwa barnacles attached to them, but they seemed to have no effect on the growth.

At the Usu Fishermen's Cooperative the andon (cylindrical) type rearing apparatus was used for rearing.

The location for the vertical lowerings was at the same place where the seedling rearing was carried out. p.35

On March 14, 1965 an average of 30 shells per layer were put in place and rearing was carried out until September 1965. A lot of kelp grew on the nets, and all the rearing equipment had either blue mussel or Kasan-ekanzashi attached to them. With regard to the attachment of 'blue mussels', there were those with 10-15 of them attached to one shell, to those with none attached, and the shells being reared showed an even growth with no abnormalities.

The rearing of the seedling shells for growth was done using 2 types (multi-layered and andon (cylindrical) types) of methods, and the average size of the reared seedlings were a shell length of 79 mm, a shell height of 78 mm, a shell width of 20.5 mm and an average weight of 55 g.

(3) Actual Rearing

It goes without saying that the quality of the seedlings for rearing is

important. The reared seedlings were carefully examined, substances attached on the shell surfaces were removed, the abnormal ones or the slow-growing shells were removed, and then they were reared vertically at this rearing facility. The fishing grounds for the rearings were the following 2 locations:

(A) East Hama, Date, about 1000 m offshore, water depth of 17 m.

(B) North Usu, Date, about 1500 m offshore, water depth of 17 m.

With regard to the setting up of these 2 fishing grounds, they were set up on the predication that because of the locations the growth and the durability of facilities would naturally be different, along with changes in the oceanic conditions.

The equipment used for this rearing was an extended rope vertical-type (Figure 13), and the rearing apparatus was a multi-layered type (using polyethylene pipe with a 15 mm diameter, rings of 55 cm in diameter were made, and crosses made of 6 mm diameter coating wire were tied on, and wrapped with a net of polyethylene mono-filament which had not knotting, black in color and 70 mm mesh; and 40 of these baskets were connected together); in each basket were placed a different number of shells, such as 10, 9, 8 shells, and then the growth situation,etc. were observed.

The number of seedlings used for the rearings was about 1500 shells by the Date Fishermen's Cooperative, and about 8000 shells by the Usu Fishermen's Cooperative. Vertical lowering of the rearing apparatuses at the (A) fishing grounds was done on September 25, 1965, and at the (B) fishing grounds on September 10-15, 1965. p.36

With regard to control operations on the seedlings placed in the rearing apparatuses, at the Date Fishermen's Cooperative the operations were done only one time on May 25, 1966, about 250 days after the vertical rearing began,

where 'Ooiwa barnacles' attached to the shell surfaces of the reared shells (7-16 mm high 'Ooiwa barnacles' were well adhered on portions of the shell surfaces) and other substances were removed and the rearing apparatus was exchanged at the same time; and at the Usu Fishermen's Cooperative, the rearing was carried out without even touching the reared shells during the rearing period. The rearing period for the Date Fishermen's Cooperative was from September 25, 1965 to December 13, 1966, and for the Usu Fishermen's Cooperative it was from September 15, 1965 to August 25, 1966. Investigations with regard to growth were done 5 times at the (A) fishing grounds and 4 times at the (B) fishing grounds; the method of investigation involved pulling up the series rearing apparatus for each stored number of shells, and from each one basket an average growth shell was selected (40 shells were taken out from the series rearing apparatus), and the shell lengths, shell heights, shell widths, weights, and/or flesh weights, **volume of adductor muscle and the like** were observed or measured. However, in this experiment, not removing the attached substances at the appropriate times appears to have inhibited the growth. The results of the growth investigations are shown in Table 17.

For the growth, the shell lengths and the shell heights showed proportional growths, and the weights had increased at a very rapid rate. With regard to the growth levels at the (A) fishing grounds after 15 months of rearing, if the shell measurements at the time of placement are given a value of 10, the growth ratios obtained are 4.9 for the shell length, 4.1 for the shell length (height?), 21 for the shell width, 83.7 for the weight, and the weight increase is particularly obvious. When the shell length of the reared shells grew to more than 11 cm, the weight tended to increase rapidly; when the shell length grew from 11.2 cm to 13.2 cm, the shell weight of 181 g

p.39

increased to 285 g.

Also for the naturally occurring shell inhabitants, the weight increases are clearly seen: for the scallops at Date, the 2-year old shells with a shell length of 12.6 cm, a shell height of 12.2 cm, an shell width of 3.6cm and a weight of 230 g grew in the 3-year old shells to a shell length of 13.4 cm, a shell height of 13.0 cm, a shell width of 3.5 cm and a weight of 303 g.

Among the shells stored in the rearing apparatus, during the growing process there was no 'fighting' which occurs by swimming movements, etc., but at both the (A) and (B) fishing grounds the occurrence of dead shells was found, although the reason for this are unknown. In the series of rearing apparatuses this was observed to have occurred for about 3%. With respect to the growth for each storage number, there were growth differences related to the storage density, and when the shells of storage number 8 were compared the shells of storage number 10, there was a 7-10% growth difference in the shell length. Now, for the case of the shells where 10 were stored per layer, along with the growth there was an 'unevenness' in the growth, and after 8 months of rearing, about 6% of abnormal shells occurred in the rearing apparatus series.

For the growth of each layer along the vertical water depths at the (A) and (B) fishing grounds, the differences observed were small. That is, at the (A) fishing grounds, except for one section, from the upper layers to the lower layers, each layer showed an average growth, and at the (B) fishing grounds the upper and middle layers had average growths, but compared to these, the lower layers showed an inferior growth. However, at the (B) fishing grounds the investigations were halted 4 months earlier than at the (A) fishing grounds, and thus accurate comparisons cannot be made, but the growths

for the same time period were better for the (A) fishing grounds.

These differences are considered to be related to the water temperature, currents, nutrient salts, feeding quantities, assimilation efficiencies, etc. The nutrient salts which are essential for the life of plant plankton are silicates, phosphates, nitrates, nitrites, ammonium salts, etc., and because scallops feed on plant plankton, for reference the water quality was analyzed for each water depth at the (A) fishing grounds at the highest and lowest water temperature periods, and the results are shown in Table 19. p.42

(4) Discussion

For scallops reared by the vertical cultivation method, during the first year rearing period, growth differences occur with water depth (also related to storage density); but with this rearing method, although there are seasonal water temperature variations at the rearing fishing grounds, there are few effects on the growth of the shells being reared, and also the growth differences due to water depth are small.

With the rearing period (including the mid-rearing period) of about 2 years and 1 month, shells meeting the conditions for marketability are obtained, but depending on the storage density of the rearing apparatus, the growths are different, and when the shell length of the reared shells reaches 13.0 cm, the weight rapidly increases.

For three-dimensional usage of the rearing fishing grounds, the vertical rearing method of scallops can be said to be ideal, but considering the weight increases in the reared shells, the number of rearing apparatuses to be linked together must be studied.

Control operations of the reared shells should focus on removing the substances attached to the shell surfaces, and also mono-filament nets are

preferred because not many diatoms attach to them; and at least once during the rearing period (during the actual growth rearing) the rearing apparatuses must be changed.

When the growths of released shells are compared to that of the reared shells, after a period of 2 years and 1 month, the shells (comparison of the released shells in the fishing prohibited area and the reared shells at East Hama,Date) had weights of 237.0 g for the released shells and 285.5 g for the reared shells. However, on the shell surfaces of the reared shells, compared to the released shells, many bumpy impediment rings are formed. When the results of the vertical rearing tests (Jijyobu Ana-ake Saikaho) done at Origasa, Yamada-cho Prefecture are compared to the growth of the vertical reared shells at Date, although the rearing methods are different, for the shell length of 4.0 cm (May) to grow to 13.5 cm required about an 8 month period to the end of December of the same year. In the Date case, however, the shell length of 4.5 cm (March) reached 13.7 cm in December of the following year, a period of about 21 months. p.44

About 80% of the reared shells had the right shell facing down (in the rearing apparatus), and the shell color was mostly a pale cement color, while the others were a pale milky brown color.

For the bottom inhabiting scallops (2 year shells) the ratio of the shell length to the shell width is 24, but this ratio for the reared shells is 28, and with the left-right shells the reared shells have a characteristically rounder shape than the sea-bottom inhabiting shells. The substances attached to the reared shell surfaces were mainly Ooiwa barnacles, and along with the process of the actual rearing, Hidaberi and sea anemone were attached regardless of the water depth.

We would like to thank the staff and the youth groups at the Date and Usu Fishermen's Cooperatives, Mr. Kiyoshi YOSHIZUMI of the investigation section, the Hokkaido Fishery-Hatchery for water quality analyses, and Mr. Tamotsu KIJIMA who helped build the rearing apparatuses.

Diagram of the locations of the seedling collection-rearing test facilities at Date, Higashi-Hama

Figure 1

(第1図)

伊達町字東浜地先の採苗、養殖試験施設設置略図

A 昭和40年までの ——— A Up to 1965

A 昭和40年までの採苗漁場 —— A Seedling collecting fishing grounds up to 1965

B 垂下養殖試験漁場 —— B Vertical rearing test fishing grounds

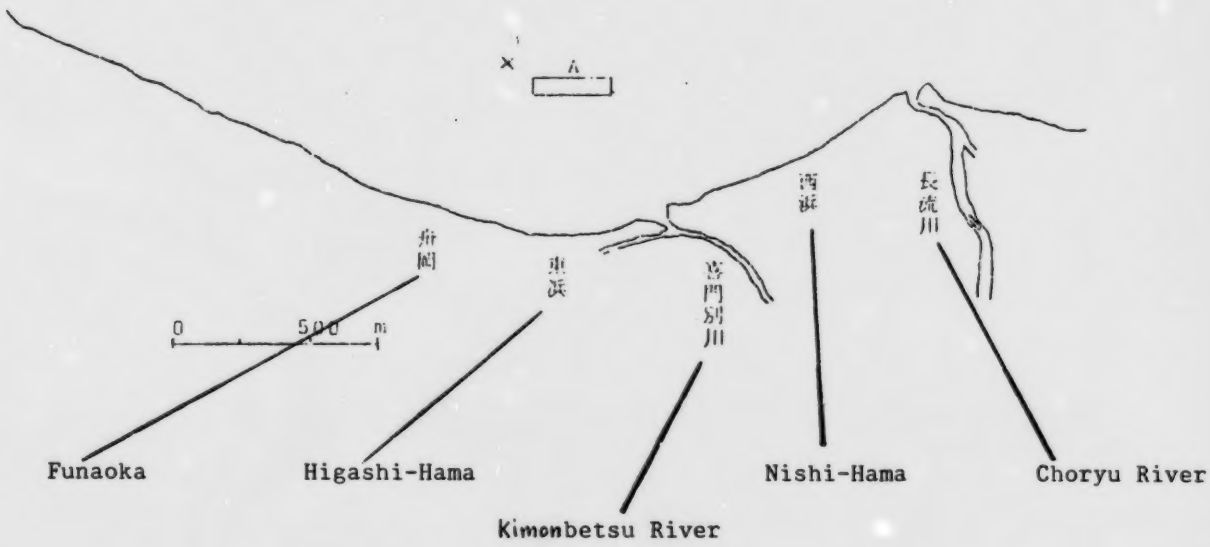

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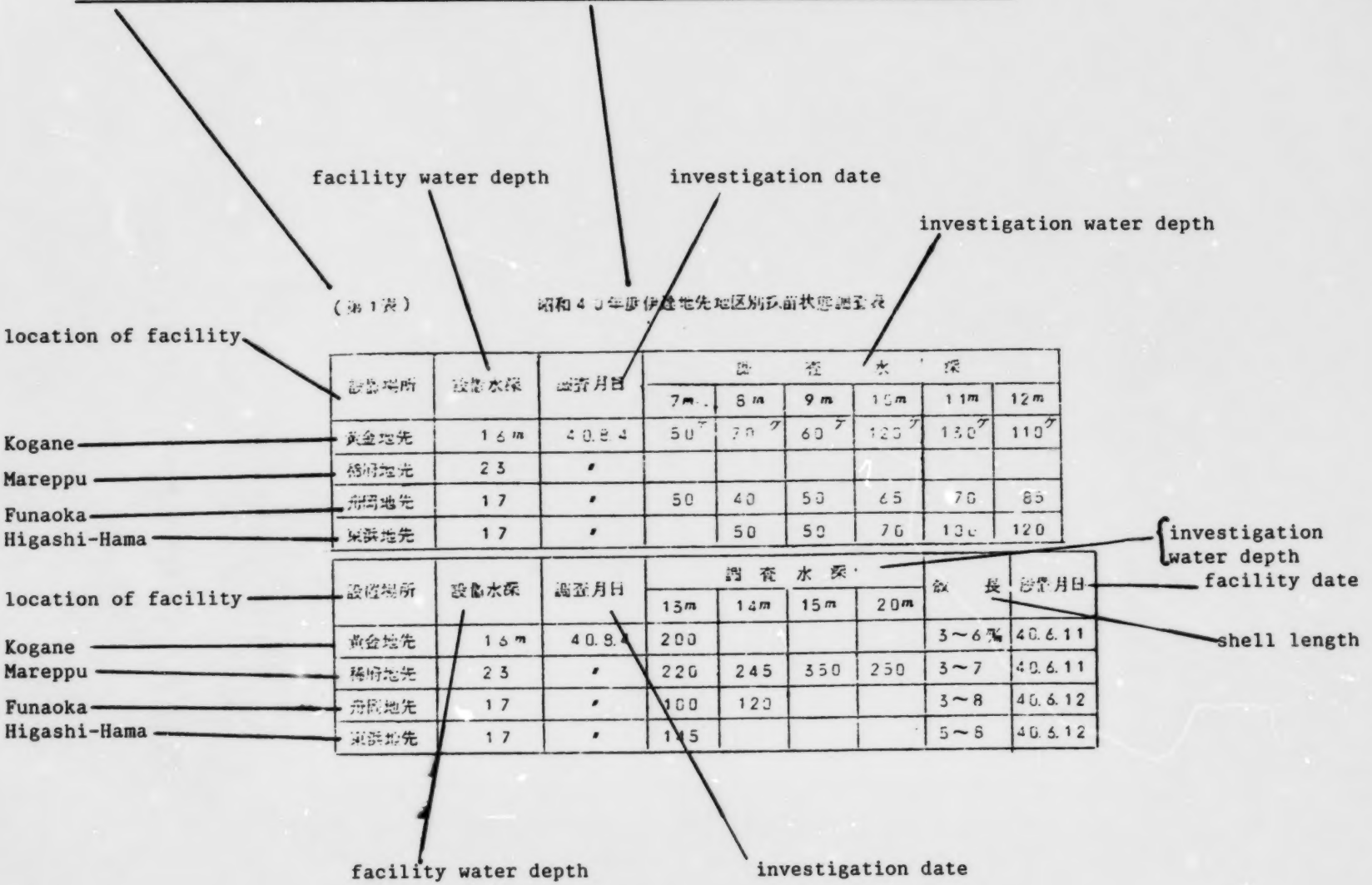
Table 1. The 1965 Seedling Collection Investigation at Locations around Date



(第1表)　昭和40年度伊達地先地区別採苗状態調査表

設置場所	設置水深	調査月日	調査水深 7m	8m	9m	10m	11m	12m
黄金地先	16m	40.8.4	50ア	70ク	60ア	120ア	130ク	110ク
稀府地先	23	〃						
舟岡地先	17	〃	50	40	50	65	70	85
東鉄地先	17	〃		50	50	70	100	120

設置場所	設置水深	調査月日	調査水深 13m	14m	15m	20m	殻長	調査月日
黄金地先	16m	40.8.4	200				3～6㍉	40.6.11
稀府地先	23	〃	220	245	350	250	3～7	40.6.11
舟岡地先	17	〃	100	120			3～8	40.6.12
東鉄地先	17	〃	145				5～8	40.6.12

Figure 2 Plans of the Scallop Seedling Collection Test Facilities for each Date Location in 1965

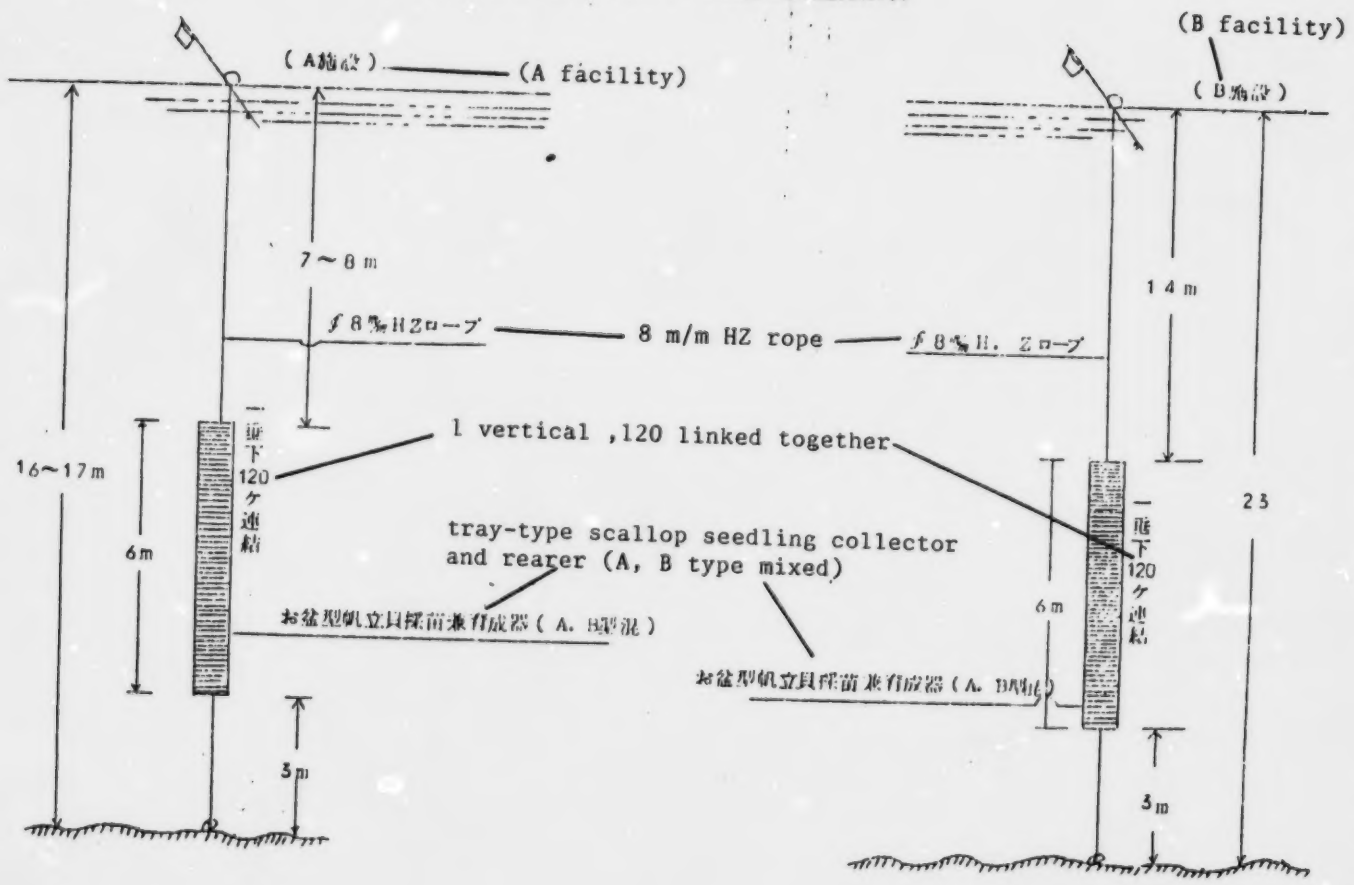


Diagram of the 1964-1965 Polyethylene Film Seedling Collector Facility

Figure 3

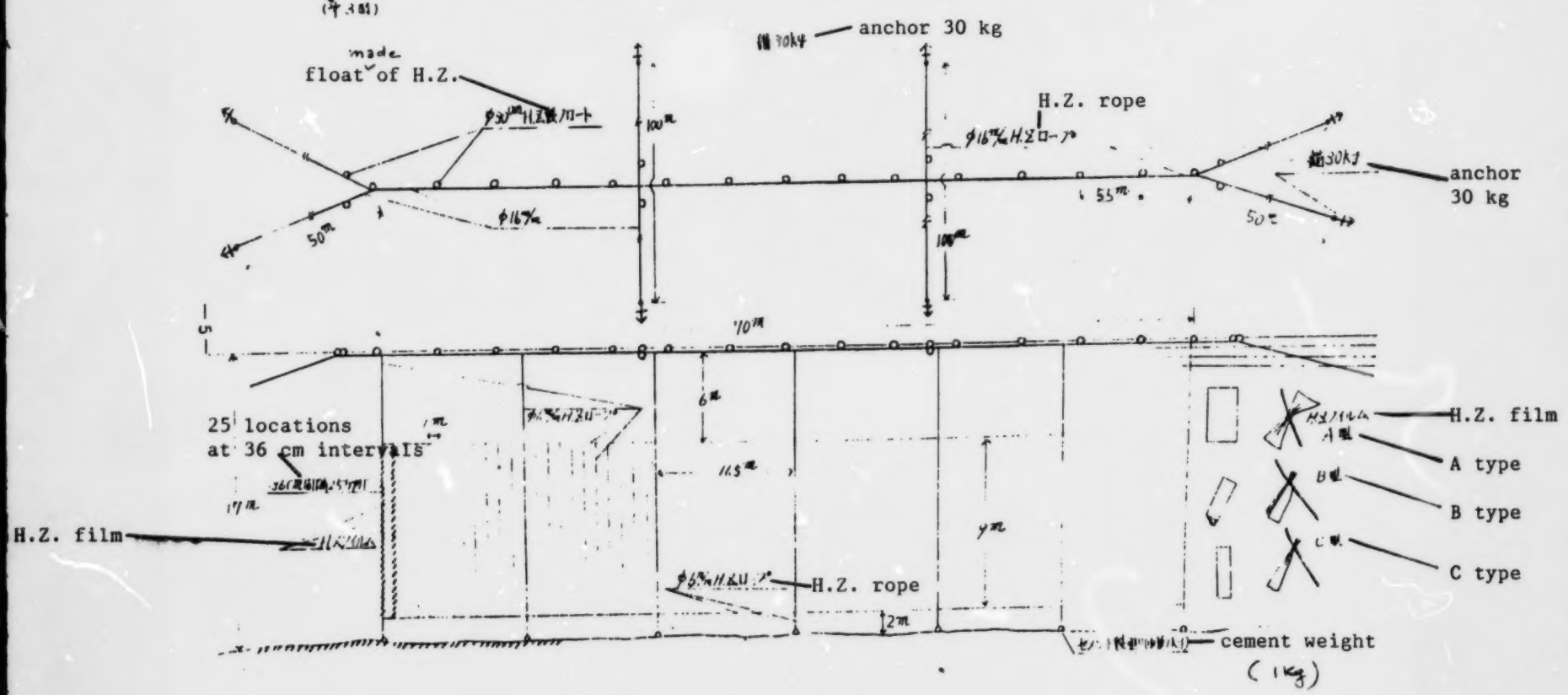


Figure 4 Diagram of the 1965 Tray-type Scallop Seedling Collecting-Rearing Facility

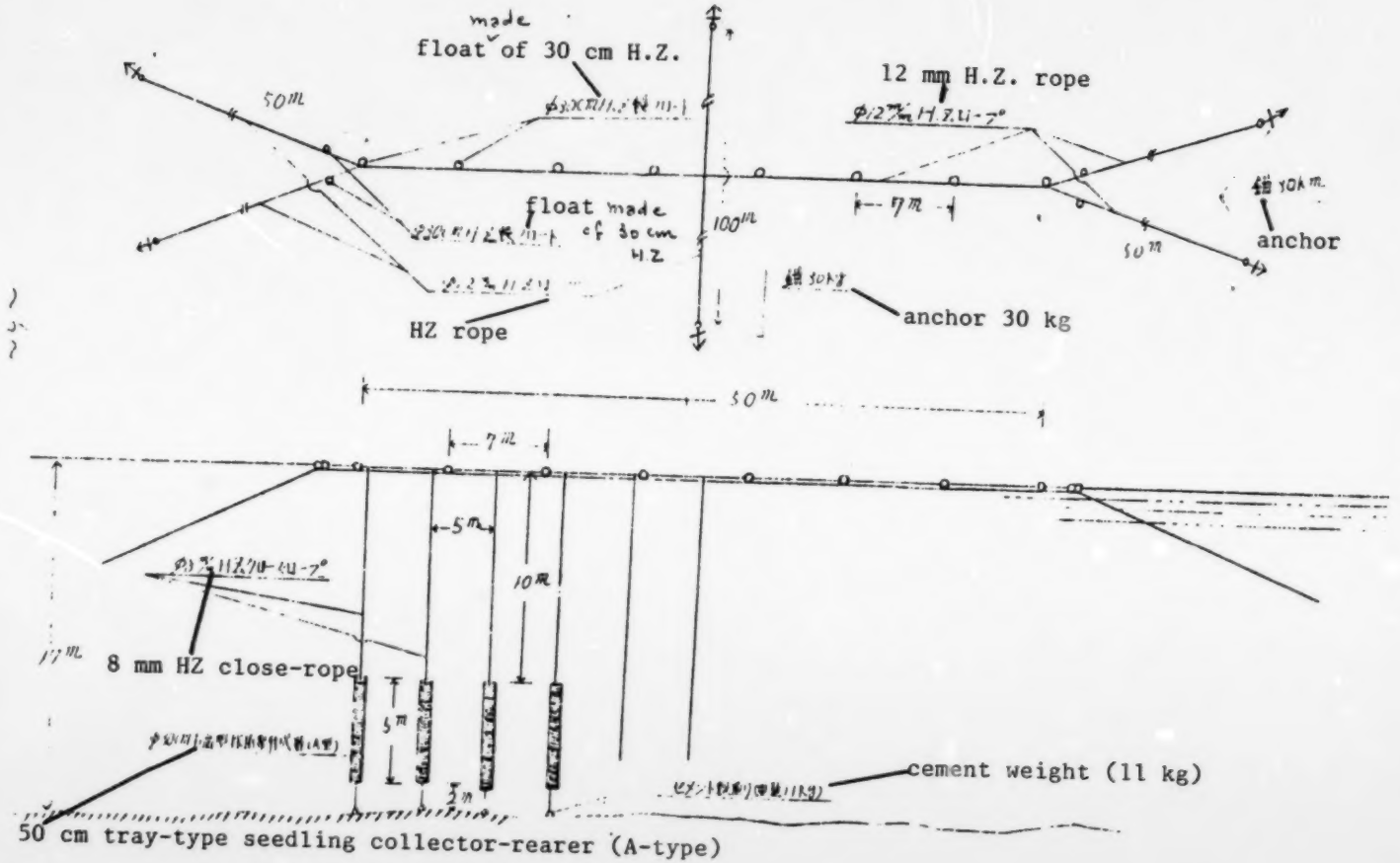


Figure 5 Diagram of the 1966 Tray-Type Scallop Seedling Collecting-Rearing Facility

(寸5図) 昭和41年度 垂下型ホタテ稚貝採苗養成器実験図

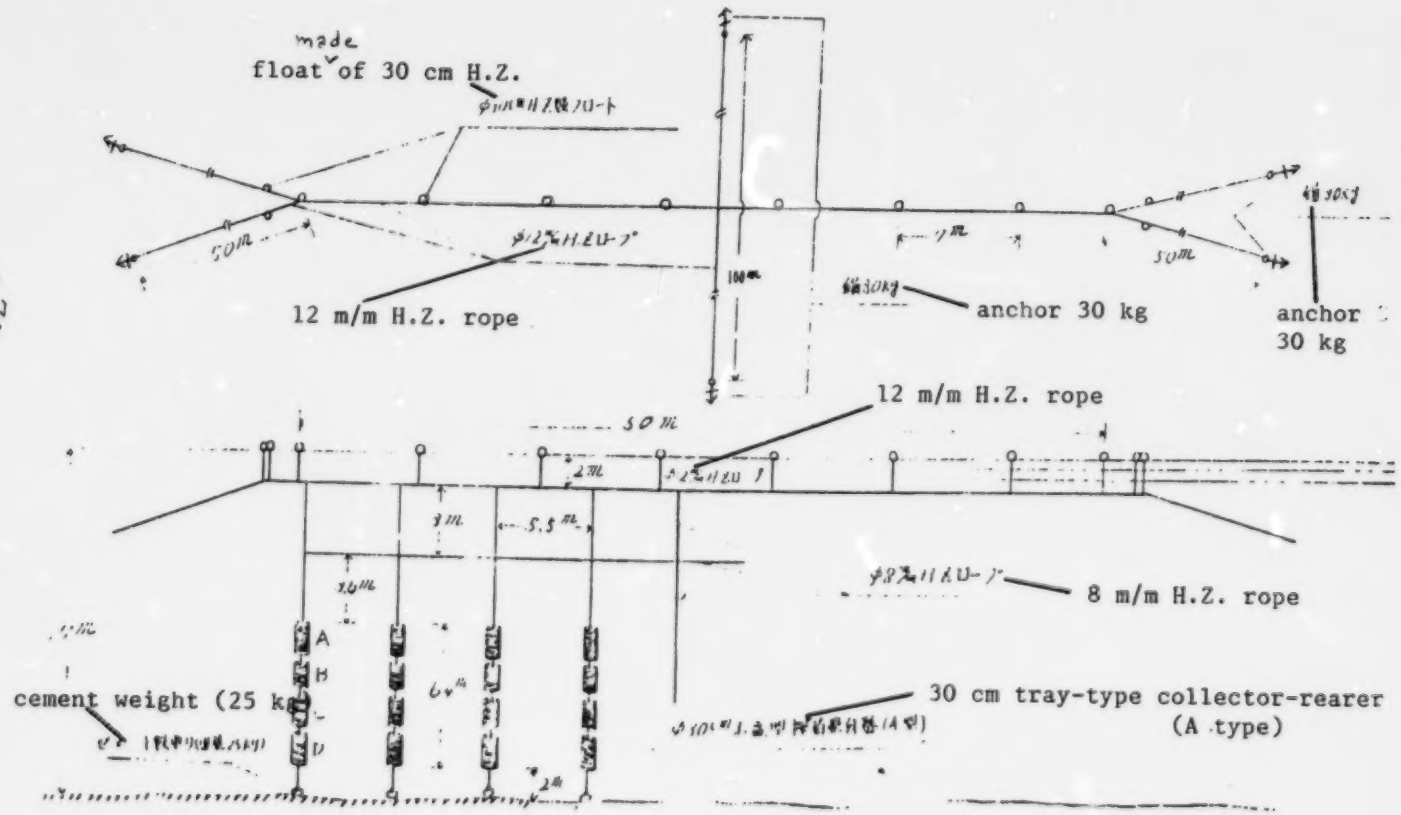


Table 2 The Results of the Collection of Natural Scallop Seedlings at Date

year — name of collection facility — facility date — number of facilities — date of seedling collection — number of seedlings collected per series — number of seedlings per facility — total estimated number of seedlings — shell length at time of investigation

（第2表） 伊達地先ホタテガイ天然採苗成績調査表

実施年度	採苗施設名	設置月日	設置基数	採苗月日	1連における採苗個数	1基の採苗推計個数	採苗総推計個数	殻長
1956 昭31年	手綱式	5月21日	2	8月 7日	30cm 〜約5(個)	120,000個	240,000個	3.0〜
昭31年	ホタテガイ成垂下式	〃	2連	〃	1m×1枚 〜10			
1957 32	手綱式	5月28日	1	8月17日	30cm 〜 4	58,600	345,900	2.0〜14.0
	ホタテガイ成垂下式	〃	1	〃	1(連)4.5m 〜 1,707	307,300		
1958 33	手綱式	6月 2日	1	8月 8日	30cm 〜 5	44,000	326,600	3.0〜10.0
	ホタテガイ成垂下式	〃	2	〃	1連3m 〜 785	141,300		
1959 34	杉葉垂下式	6月 8日	2	8月 1日	1連9m 〜 2,250	112,500	225,000	3.0〜
1960 35	〃	6月12日	9	8月 4日	1連9m 〜 1,485	74,250	668,300	3.0〜
1961 36	〃	6月 4日	20	8月 1日	1連9m 〜 6,750	675,000	13,500,000	3.0〜
1962 37	〃	6月 2日	20	8月25日	1連9m 〜 4,030	403,000	8,060,000	6.0〜15.0
1963 38	手綱式	6月 5日	5	8月23日	30cm 〜 77	154,400	8,194,800	3.0〜 5.0
	杉葉垂下式	〃	5	〃	1連12m 〜15,900	1,590,000		2.0〜 7.0
	ポリエチレン・フィルム垂下式	6月18日	9連	9月 3日	1本18m 〜18,623	167,600		2.0〜13.0
1964 39	杉葉垂下式	6月10日	2	7月26日	1連18m 〜 5,731	373,100	1,778,176	4.0〜15.0
	ポリエチレン・フィルム垂下式	〃	8	〃 日	1連9m 〜 1,667	118,357		
	お盆型採苗兼育成器	6月 7日	580個	9月 1日	1連200個〜28,000	85,120		
1965 40	ポリエチレン・フィルム垂下式	6月10日	8	8月19日	1連12m 〜 740	52,552	949,916	6.0〜15.0
	お盆型採苗兼育成器	〃	5	〃	1連100個〜9,627	105,900		11.0〜14.0
1966 41	ポリエチレン・フィルム垂下式	6月11日	8	7月30日	1連9m 〜 4,565	323,975	4,367,384	2.5〜 7.5
	お盆型採苗兼育成器	〃	20	〃	1連110個〜8,878	88,780		4.0〜 8.5

Table 2 (continued)

year	name of collection facility	facility date	date of seedling collection	number of seedlings collected per series
1956	landing net type	May 21	August 7	30 cm^2 - about 5 shells (1 ind.)
	scallop-shell vertical type	"	"	1 shell - 10
1957	landing net type	May 28	August 17	30 cm^2 - 4
	scallop-shell vertical type	"	"	1 series 4.5m - 1.707 (1 ser.)
1958	landing net type	June 2	August 8	
	scallop-shell vertical type	"	"	
1959	willow leaf vertical type	June 8	August 1	1 series 9m - 2.250
1960	"	June 12	August 4	
1961	"	June 4	August 1	
1962	"	June 2	August 25	
1963	landing net type	June 5	August 23	
	willow leaf vertical type	"	"	
	polyethylene film vertical type	June 18	September 3	
1964	willow leaf vertical type	June 10	July 26	
	polyethylene film vertical type	"	"	
	tray-type seedling collector-rearer	June 7	September 1	
1965	polyethylene film vertical type	June 10	August 19	
	tray-type seedling collector-rearer	"	"	
1966	polyethylene film vertical type	June 11	July 30	
	tray-type seedling collector-rearer	"	"	

(1 ser.) = series

(1 ind.) = individual

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Table 3

The 1963 Scallop Seedling Collection Results

Date, Higashi-Hama (test on September 3, 1963)

（第3表）　昭和３８年度ホタテガイ採苗成績調査表

伊達町字東浜地先　（３８.９.３調）

water depth

count

number attached within 1 meter of water depth

水深	1m	2	3	4	5	6	7	8	9	10
水深1m間の付着数	個 25	125	637	950	1,787	513	1,150	200	675	213

水深	11m	12	13	14	15	16	17	18	合計
水深1m間の附着数	個 3,680	2,812	737	2,675	6,125	1,087	—	—	23,279

合計 — total number

Table 4 The 1964 Scallop Seedling Collection Results

Date, Usu (investigation of July 27, 1964)

Date, Higashi-Hama (investigation of July 26, 1964)

（表4参）

昭和３９年度ホタテガイ採苗成績調査表

伊達町字有珠（３９.７.２７調）

伊達町字東浜地先（３９.７.２６調）

A type

B type

	A 型		B 型
1	5 ケ	1	— ケ
2	4	2	1
3	2	3	6
4	9	4	2
5	13	5	2
6	19	6	13
7	17	7	—
8	8	8	—
9	22	9	6
10	17	10	2
11	15	11	11
12	10	12	4
13	24	13	4
14	11	14	5
15	15	15	11
16	13	16	12
17	24	17	7
18	30	18	14
19	34	19	25
20	37	20	31
21	35	21	14
22	40	22	30
23	67	23	19
24	—	24	42
25	—	25	31
計	469ケ	計	287ケ

TOTAL

	A 型		B 型
1	— ケ	1	9 ケ
2	23	2	44
3	27	3	35
4	26	4	37
5	45	5	46
6	48	6	31
7	28	7	28
8	24	8	38
9	30	9	20
10	56	10	36
11	65	11	14
12	51	12	43
13	65	13	27
14	125	14	26
15	100	15	11
16	128	16	20
17	97	17	24
18	88	18	7
19	178	19	35
20	134	20	38
21	193	21	46
22	189	22	32
23	230	23	44
24	237	24	55
25	241	25	71
計	2428 ケ	計	817ケ

total

Table 5. Scallop Seedling Collection Results of 1965

Polyethylene film seedling collector No. 6 (investigated Aug. 9, 1965)

(第5表)

ポリエチレン・フィルム採苗器 No.6 (40.8.9 調)

	コレクターの大きさ (H. Zフィルム)	稚貝の大きさ 最高	稚貝の大きさ 主体	附着稚貝数	摘要
1	25×50cm	15%	12%	6個	最低 6%
2	〃	15	〃	3	
3	16×60	15	〃	10	
4	25×50	14	11	6	
5	〃	14	〃	11	
6	〃	13	10	40	
7	16×60	14	11	11	
8	〃	13	10	6	
9	〃	13	〃	3	
10	〃	14	11	22	
11	〃	14	〃	50	
12	25×50	13	〃	63	
13	16×60	14	12	3	
14	〃	15	〃	1	
15	〃	14	11	24	
16	〃	14	〃	61	
17	〃	13	〃	71	
18	25×50	14	〃	—	
19	16×60	14	11	25	
20	25×50	15	10	40	
21	〃	14	11	72	
22	〃	15	12	16	
23	〃	13	〃	14	
24	〃	14	11	12	
25	16×50	14	〃	17	
計	〃	14	〃	585ケ	

totals

size of young shell

size of collector (H.Z. film)

maximum { main body

number of attached young shells

notes

minimum 6 m/m

昭和40年度ホタテガイ採苗成績調査表

Polyethylene-film seedling collector

Date, Use (investigation of Sept. 13, 1965)

Tray-type seedling collector-rearer

number attached per collector

ポリエチレン・フィルム採苗器

伊達町字有珠地先

(40.9.13 調)

お盆型採苗兼育成器

コレクター1枚当り付着ケ数		
最高	最低	平均
415	16	55
217	6	26
207	20	41
266	4	37
187	11	43

maximum minimum average

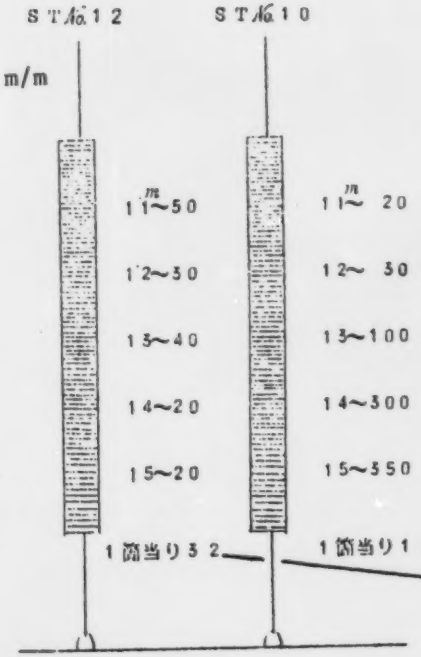

Table 6 - 1

Scallop Seedling Collection Results of 1966

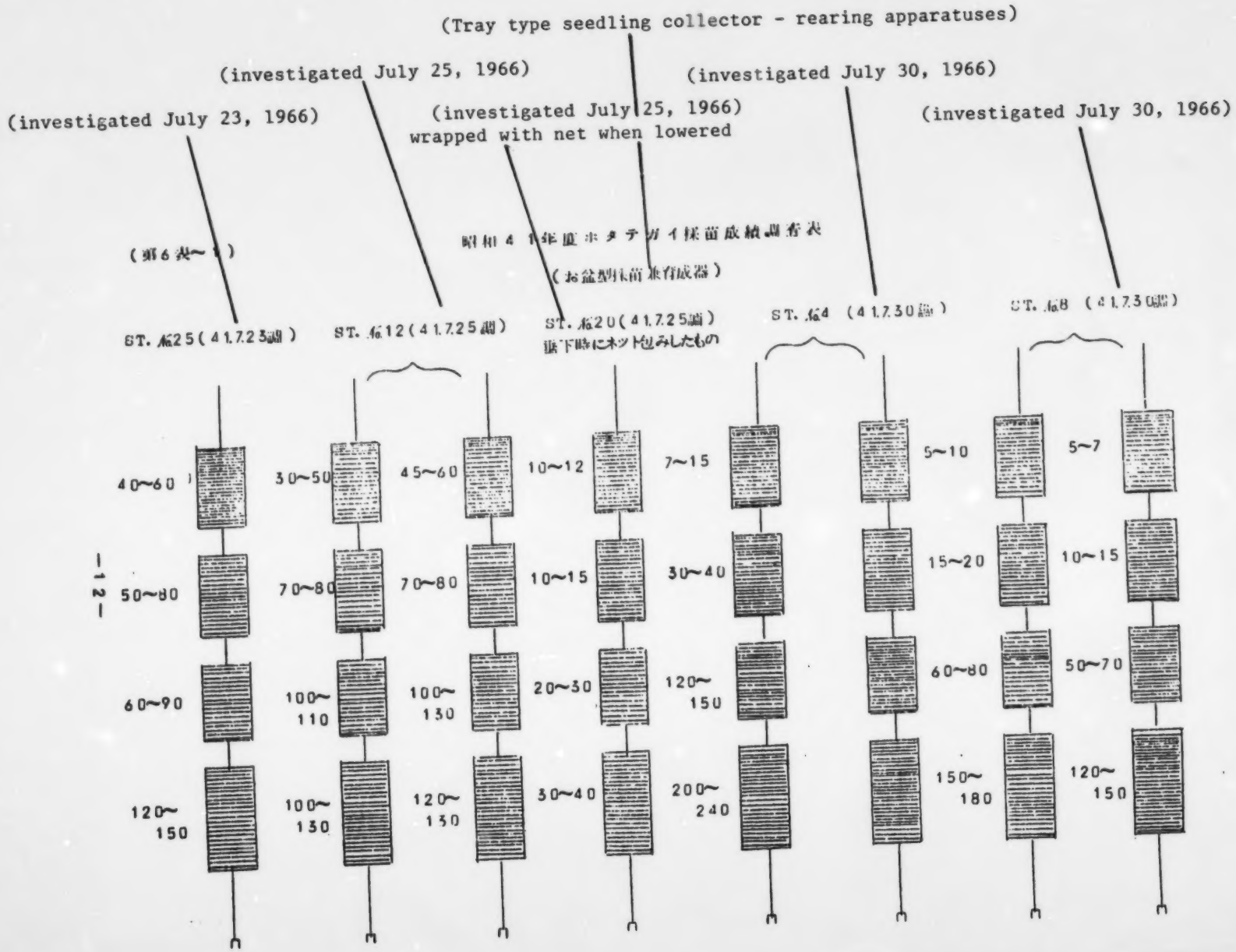

Table 6 - 2 Scallop Seedling Collection Results of 1966

Polyethylene film seedling collector (investigated on July 23, 1966)

(第6表～2)

昭和43年度ホタテガイ採苗成績調査表

ポリエチレン・フイルム採苗器(41.7.23設)

S.T. 16

size of collector (HZ film)

size of young shells: maximum | minimum

no. of attached young shells

notes

	コレクターの大きさ (HZフイルム)	稚貝の大きさ 最高 maximum	稚貝の大きさ 主体 main body	附着稚貝数量	摘要
1	16×60 cm	7㍉	4 ㍉	40 粒	最小1㍉
2	〃	〃	〃	60	
3	〃	〃	〃	50	
4	25×55	〃	〃	120	
5	〃	6	〃	90	
6	16×60	7	3	90	
7	25×55	〃	4	110	
8	〃	〃	〃	140	
9	16×55	6	〃	90	
10	〃	7	3.5	80	
11	25×55	〃	〃	110	
12	16×60	6	4	60	ヒトデ2～3 3㍉
13	〃	〃	〃	250	
14	25×55	7	〃	120	
15	〃	〃	3	325	片面10×10cm=75粒
16	16×60	〃	〃	130	
17	〃	〃	4	150	
18	25×55	〃	〃	180	
19	〃	6	〃	180	
20	〃	7	〃	320	フジツボ附着
21	16×60	〃	3.5	395	泥かぶりに成つている(以下同じ)
22	25×55	〃	〃	520	片面10×10cm 141粒 フジツボ40大8㍉ 小3㍉
23	〃	〃	4	430	〃 50大7㍉
24	〃	〃	〃	420	〃 30大7㍉
25	16×60	〃	3.5	410	片面10×10cm=90粒
	計			4.870	

total

minimum 1mm

starfish 2-3 3 mm

one side 10 X 10 cm =75 in number

barnacles attached

coverer with mud (the same below)

one side 10 X 10 cm barnacles 40 large 8 mm small 3 mm

large 7 mm

one side 10 X 10 cm =90 in number

Table 6-2 Scallop Seedling Collection Results of 1966

Polyethylene film seedling collector (July 25, 1966 investigation)

size of collector (HZ film)

size of young shells: maximum | minimum

number of attached young shells

(...)

昭和41年度ホタテガイ採苗成績調査表

ポリエチレン・フイルム採苗器（41.7.25調）

ST. No 11

	コレクターの大きさ (HZフイルム)	稚貝の大きさ 最高	稚貝の大きさ 主体	附着稚貝数量	摘要 (notes)
1	25×55cm	7㍉	4 ㍉	70粒	最小1㍉ minimum 1 m/m
2	〃	〃	〃	70	
3	16×60	〃	〃	120	
4	〃	6	〃	100	
5	〃	〃	3	210	
6	〃	〃	〃	110	
7	〃	〃	4	100	
8	〃	〃	3	150	
9	25×55	6	〃	160	
10	16×60	7	4	140	
11	〃	〃	〃	110	
12	〃	7	〃	100	
13	〃	〃	3	100	
14	〃	〃	4	150	
15	25×55	6	〃	250	
16	16×60	7	〃	210	
17	〃	〃	3	310	ヒトデ 2～3 3㍉, 4㍉ starfish 2-3 3 m/m, 4 m/m
18	〃	〃	〃	370	
19	〃	〃	〃	300	
20	〃	6	〃	330	
21	〃	〃	〃	410	フジツボ附着10 ヒトデ2 3㍉ barnacles attached 10, starfish 2 3 m/m
22	25×55	7	2.5	510	片面10×10cm125粒 ヒトデ附着2～3ケ 3㍉ one side 10 X 10 cm 1.25, starfish attached 2-3
23	16×40	〃	〃	490	フジツボ附着2 〃 barnacles attached 2
24	〃	〃	3	420	泥カブリ 2 〃 covered with mud 2 〃
25	〃	〃	2.5	400	
	計			5690	

total

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Table 6-3 Scallop Seedling Collection Results of 1966

Polyethylene film seedling collector (July 30, 1966 investigation)

size of collector (H.Z. film)

size of young shells: maximum | minimum

number of attached young shells

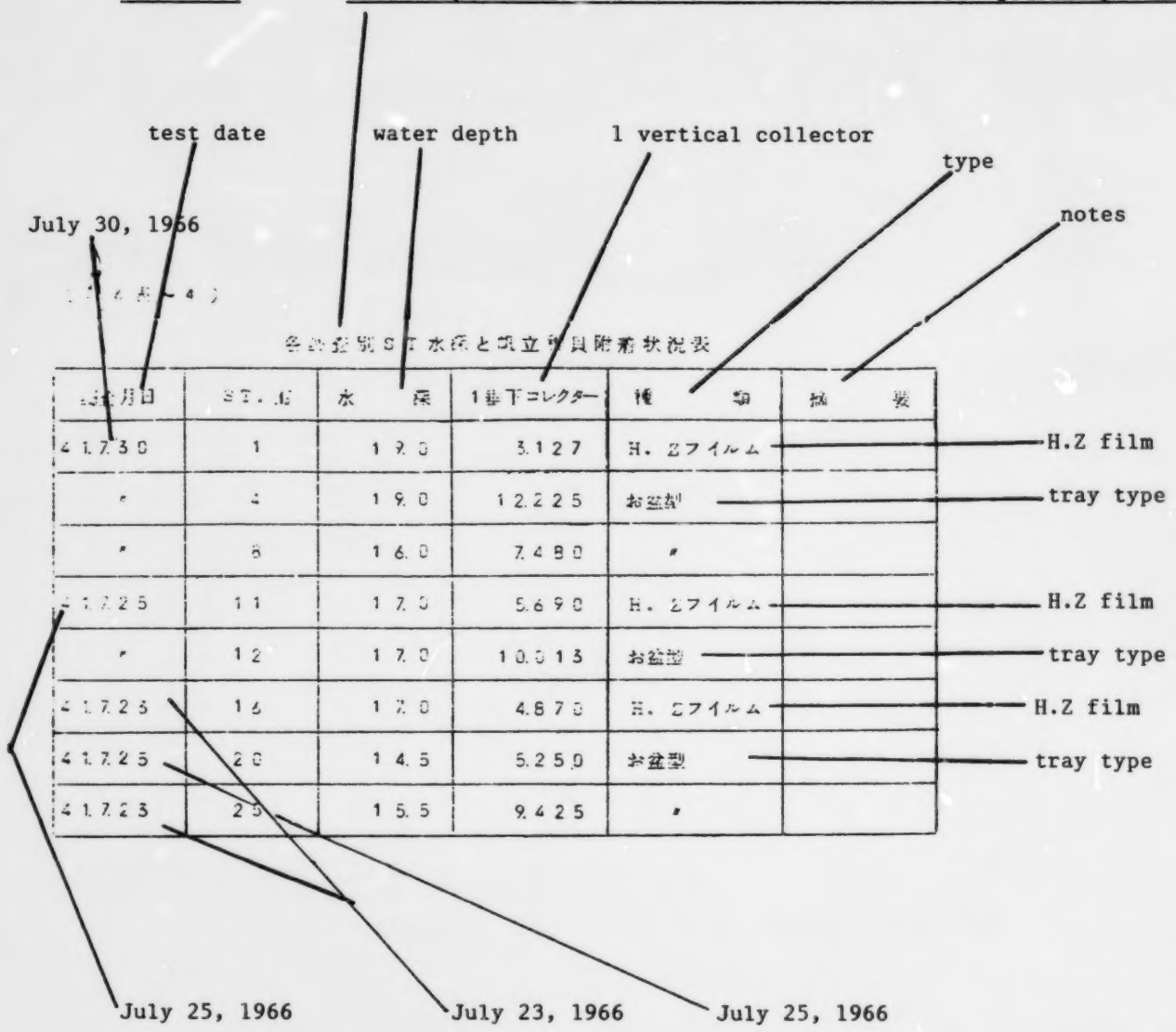
(第6表～3) 昭和41年度ホタテガイ採苗成績調査表

ポリエチレン・フイルム採苗器(41.7.30調)

S T. 瓜1

	コレクターの大きさ (H. Zフイルム)	殻長の大きさ 最高	殻長の大きさ 主体	附着稚貝数量	摘要 (notes)
1	60×50cm	7	4	5粒	最小1㍉ (minimum 1 m/m)
2	〃	〃	〃	10	
3	〃	〃	〃	10	
4	〃	〃	〃	20	
5	〃	8	〃	35	
6	〃	7	〃	20	
7	〃	〃	〃	40	
8	〃	8	〃	25	
9	〃	〃	〃	20	
10	〃	〃	〃	40	
11	〃	7	〃	12	
12	〃	〃	〃	15	
13	〃	〃	〃	20	
14	〃	〃	〃	30	
15	〃	〃	〃	40	
16	〃	8	3	130	
17	〃	〃	4	70	
18	〃	7	3	250	
19	〃	〃	〃	260	
20	〃	〃	4	160	
21	50×30	〃	3.5	250	
22	60×50	6	〃	420	フジツボ2～4 6㍉～3㍉ (barnacles 2-4 6 mm- 3 mm)
23	〃	〃	〃	125	〃
24	〃	7	〃	520	片面10×10cm=175粒 (one side 10X10 cm =175)
25	〃	6	〃	600	フジツボ殻長 (barnacle --) 片面10×10cm=110粒 (one side 10 X 10 cm=110)
				3127	

Table 6-4 Water Depth at each Site ST and the Attached Young Scallop Shells



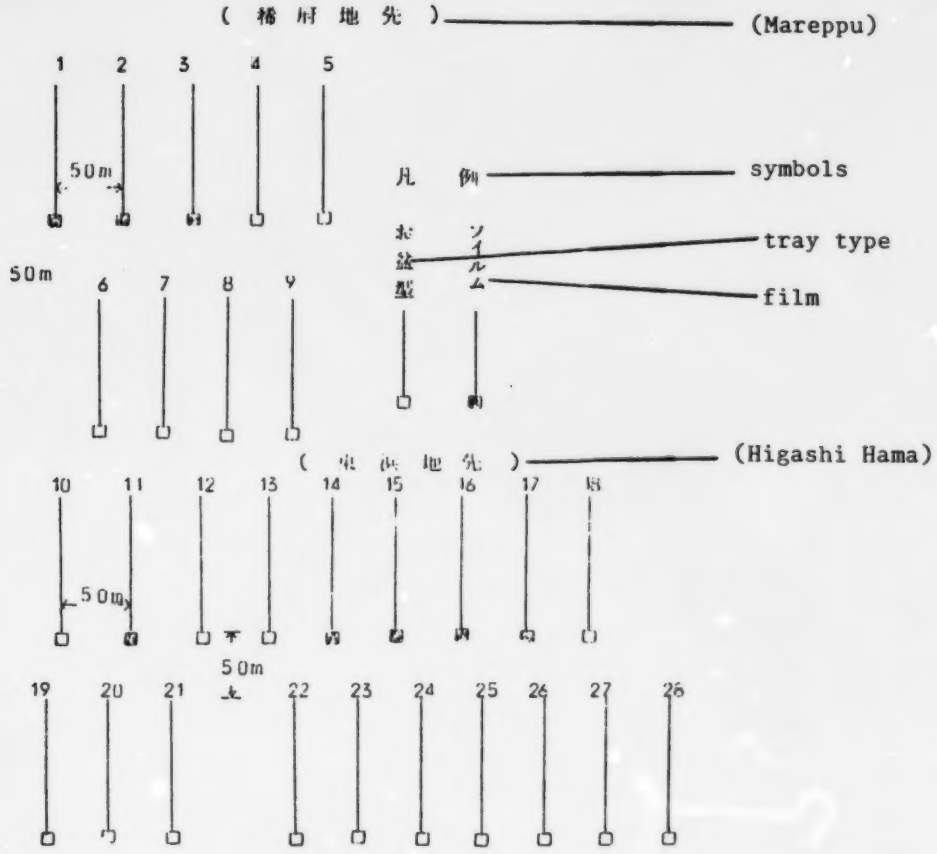
試験月日	ST. No	水深	1垂下コレクター	種類	摘要
41.7.30	1	19.0	3.127	H. Zフィルム	
〃	4	19.0	12.225	お盆型	
〃	8	16.0	7.480	〃	
41.7.25	11	17.0	5.690	H. Zフィルム	
〃	12	17.0	10.013	お盆型	
41.7.23	16	17.0	4.870	H. Zフィルム	
41.7.25	20	14.5	5.250	お盆型	
41.7.23	25	15.5	9.425	〃	

(Figure 6)

(第6図)

Diagram of the 1966 Scallop Seedling Collection Facility

昭和41年度ホタテガイ採苗施設設置図

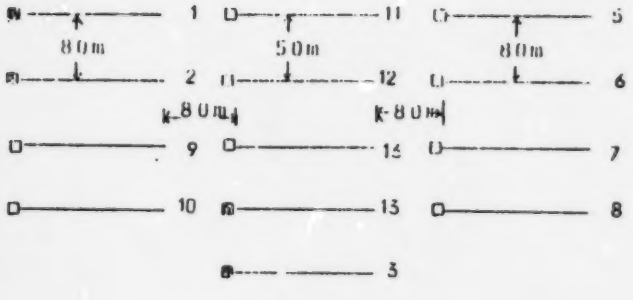


昭和40年度ホタテガイ採苗施設設置図

Diagram of the 1965 Scallop Seedling Collection Facility

(東 浜 地 先)

(Higashi Hama)



(Figure 7)

Figures of the Progress of Young Scallop Shell Attachments using the Polyethylene Seedling Collector

(第7図)　ポリエチレンフィルム採苗器の

Status of the young shell attachments for 1966 water depth

昭和41年水深における稚貝付着状態

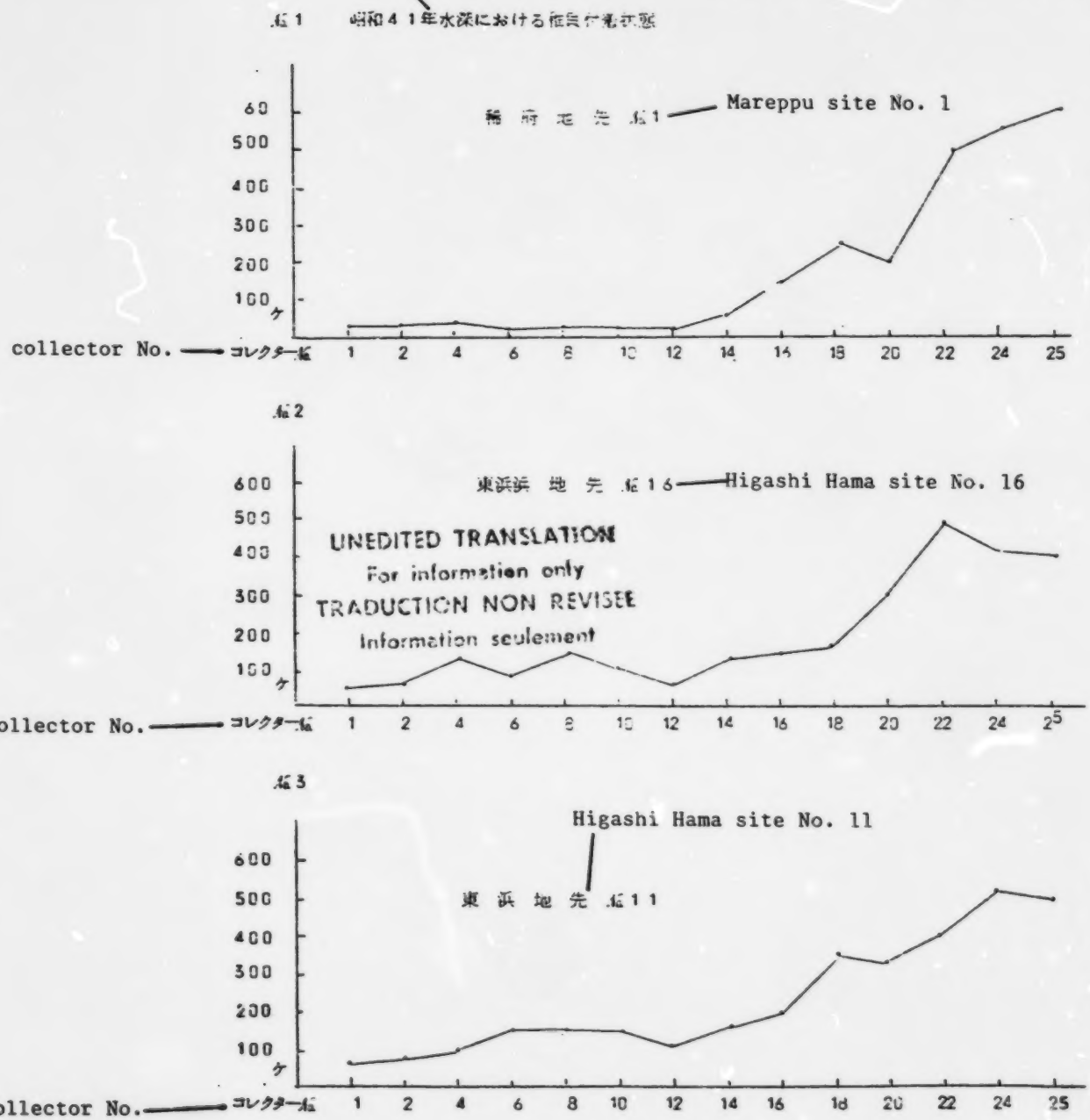


Figure 7 (continued)

Status of the young shell attachments for the 1965 water depths

ホタテガイ稚貝沿着水雄表

No. 4 昭和40年水深における稚貝付着状態

600
500
400
300
200
100
ケ

collector No. コレクター No. 1 2 4 6 8 10 12 14 16 18 20 22 24 26

Status of the young shell attachments for the 1964 water depths

昭和39年水深における稚貝附着状態

No. 5 東浜地先 No. 9

Higashi Hama site No. 9

600
500
400
300
200
100
ケ

collector No. コレクター No. 1 2 4 6 8 10 12 14 16 18 20 22 24 25

Status of the young shell attachments for the 1963 water depths

昭和38年水深における稚貝附着状態

No. 6

東浜地先（採苗試験）

Higashi Hama sites (seedling collection test)

6000
5000
4000
3000
2000
1000
ケ

m 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16

(Figure 8)

(第 9 図)

polyethylene film seedling collector

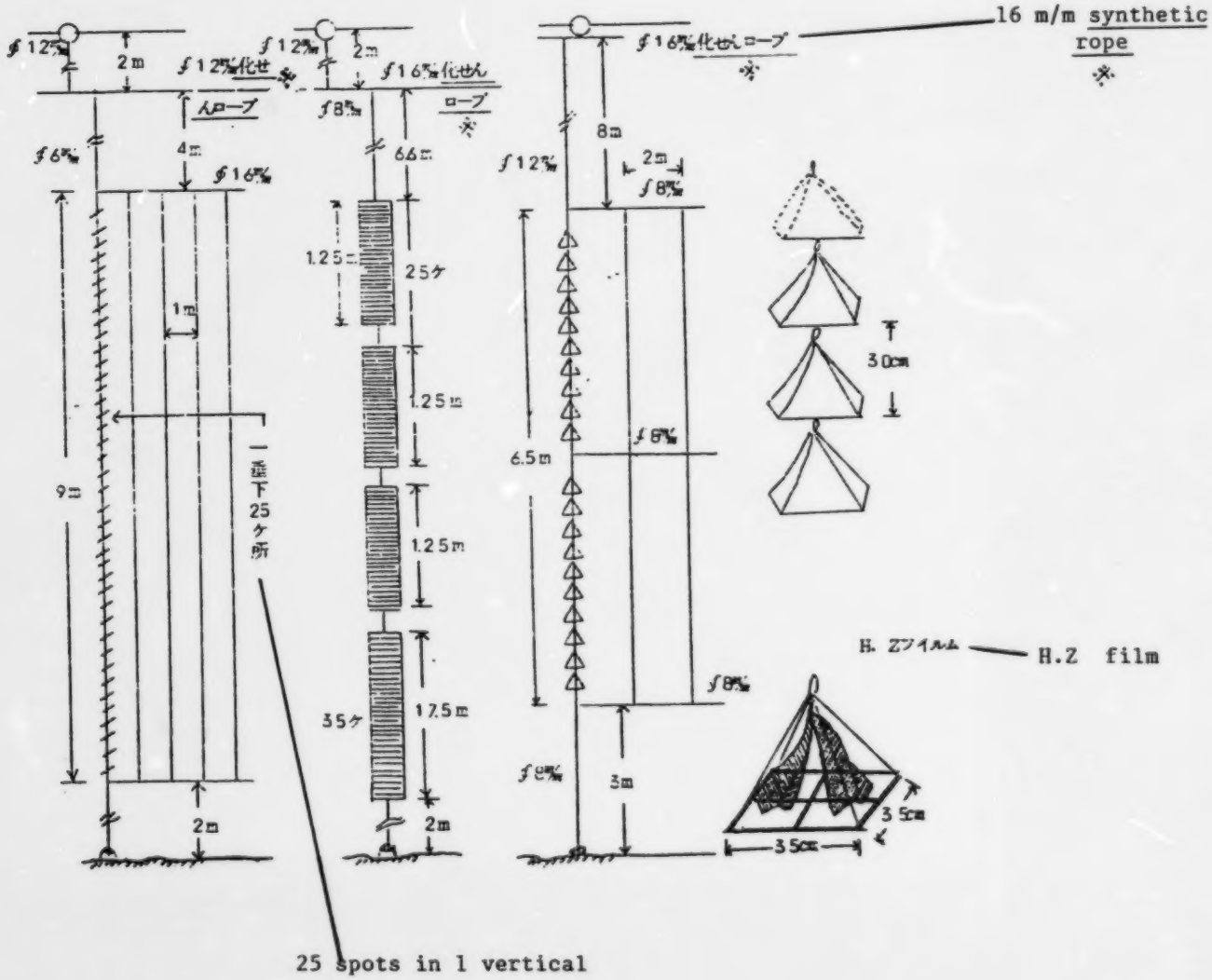
ポリエチレン・フイルム採苗器

tray-type seedling collector - rearer

お盆型採苗兼育成器

film seedling collector baskets

フイルム入り網籠採苗器



(Table 7)

Seedling Collection Results using Baskets with Polyethylene Film

Date, Usu location (August 9, 1966 investigation)

Seedling collector No. H.Z film net total

(第7表)

ポリエチレン・フイルム入り網製採苗成績調査表

伊達郡字有珠 (41.8.9.)

採苗器番号	H. Zフイルム	網 地	計
1	41ケ	9ケ	50 ケ
2	78	27	105
3	45	25	70
4	95	30	125
5	170	60	230
6	150	90	240
7	195	180	375
8	200	203	403
9	215	105	~~110~~ 420
10	310	140	~~170~~ 450
11	125	150	275
12	162	196	358
13	155	175	330
14	225	250	475
15	210	225	435
16	220	300	520
17	250	250	500
18	250	260	510
19	210	220	430
20	200	215	415

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(Table 8)

Growth of Young Scallop Shells Attached to Polyethylene Film

July | maximum | minimum | average

August | maximum | minimum | average

investigation day

investigation day

(第8表)　　ポリエチレン・フィルムに付着のホタテガイ稚貝の成長表

	7月			調査日	8月			調査日
	最高	最低	平均		最高	最低	平均	
38年	2.0㎜	0.5㎜	1.5㎜	21日	8.0㎜	2.0㎜	5.0㎜	25日
39	4.5	2.5	4.0	26	11.0	5.5	7.0	25
40	8.5	3.0	5.5	20	15.0	6.0	11.0	22
41	7.0	2.0	4.5	25	12.5	7.0	8.5	17
平均			3.87				7.87	

1963 1964 1965 1966 average

September | maximum | minimum | average

October | maximum | minimum | average

investigation day

investigation day

	9月			調査日	10月			調査日
	最高	最低	平均		最高	最低	平均	
38年	13.0㎜	7.0㎜	9.0㎜	3日	22.0㎜	10.0㎜	16.0㎜	9日
39								
40								
41								
平均								

1963 1964 1965 1966 average

(Table 9)

Studies on the Scallop Growth during Mid-Rearing

investigation date

shell length
large.small | main shell

rearing apparatus

number of stored shells per box or per layer

(第9表)

中間育成におけるチタテガイ成長状態調査表

vertical rearing location

垂下育成地所	調査月日	成長寸法 大・小	成長寸法 主体貝	育成器	1箱または1段収容個数	摘要
	8月25日	15・6ミリ	10～12ミリ		個	種貝の収容
有珠湾口	9・1	17・6	10～12	箱型	250	網地に附着状態
〃	9・20	24・14	19～15	〃	〃	〃
〃	9・30	26・18	25～23	〃	〃	〃
水深6m	10・8	30・10	25～23	〃	〃	〃
〃	10・26	35・17	28～24	〃	〃	〃
〃	11・10	38・26	35～33	アンドン型	200	〃
〃	11・28	40・29	36～32	〃	〃	収容貝半数附着状態
〃	12・20	37・25	33～30	箱型	250	収容貝全個不附着
〃	12・20	49・31	43～36	アンドン型	200	〃

August 25

15 . 6 mm

Mouth of Usu Bay

water depth 6 m

Notes

collection of young shells

attached condition on net

box type

andon (cylindrical) type

half of collected shells attached

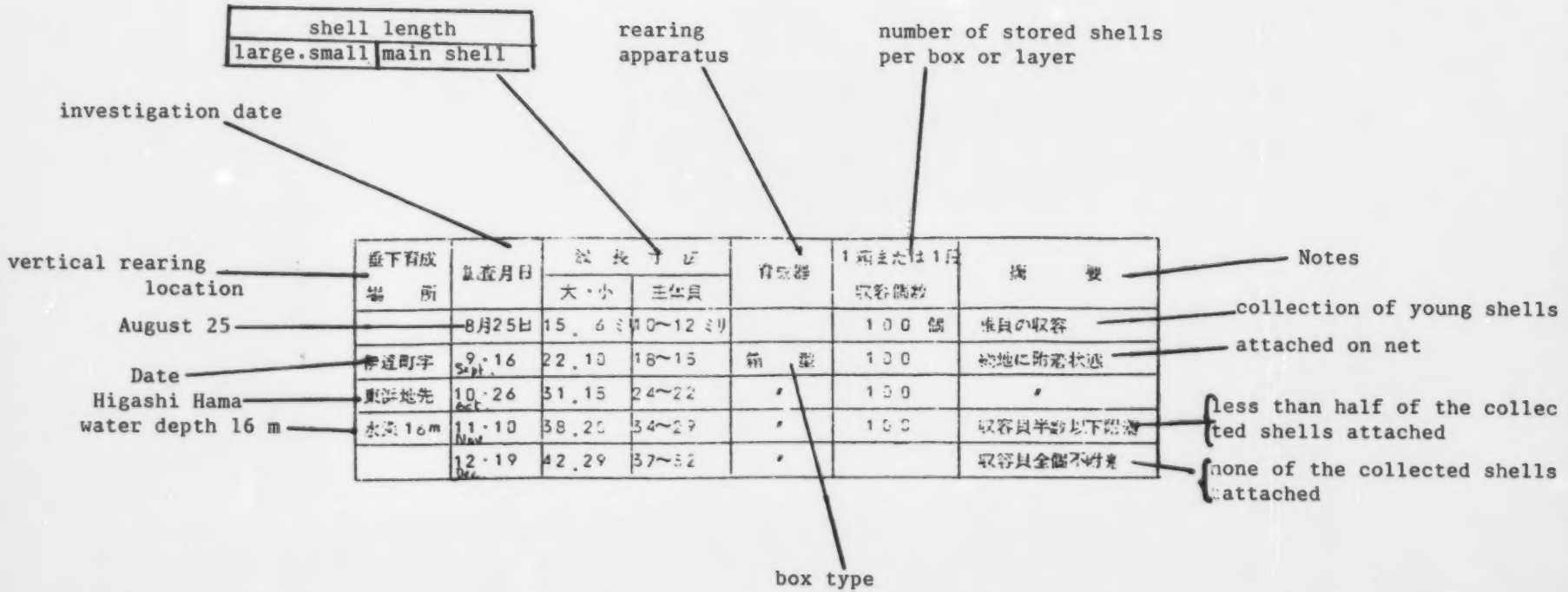
none of the collected shells attached

andon (cylindrical) type

box type

9 th Sept., 10 th Oct., etc..

(Table 9) - continued



垂下育成場所	調査月日	殻長サイズ 大・小	殻長サイズ 主体貝	育成器	1両または1段収容個数	摘要
	8月25日	15.6ミリ	10～12ミリ		100個	垂下の収容
春道町字	9・16 Sept.	22.10	18～15	箱型	100	地地に附着状況
東浜地先	10・26 Oct.	31.15	24～22	〃	100	〃
水深16m	11・10 Nov.	38.20	34～29	〃	100	収容貝半数以下附着
	12・19 Dec.	42.29	37～32	〃		収容貝全個不附着

(Figure 9) Diagrams of the Mid-Rearing Apparatus and the Vertical Method for Scallops

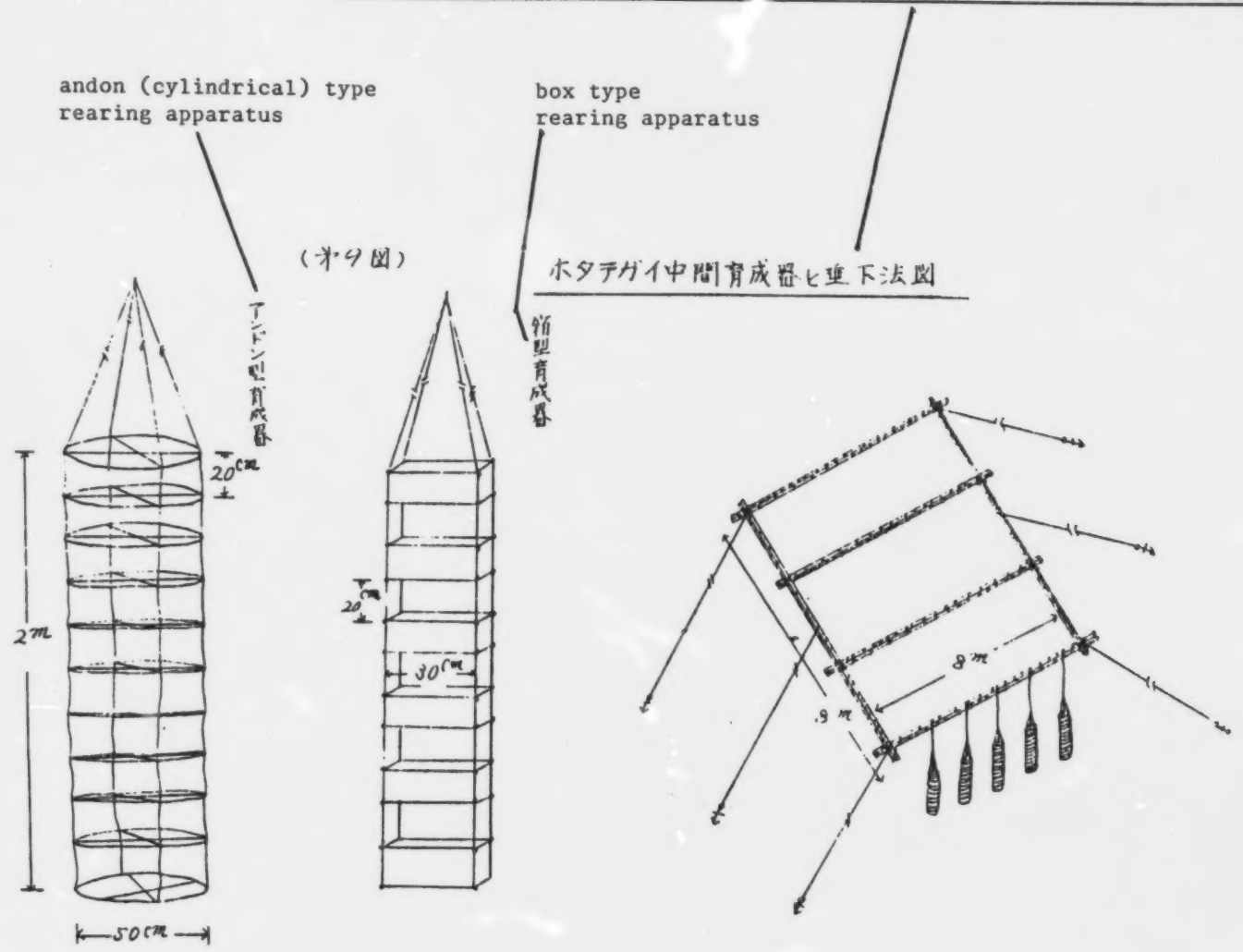


Table 10 Sizes of those Released (seedlings) during the past 3 years

(第10表)

過去3ケ年間の放流(種苗)の大きさ

年号	殻長	殻高	殻巾	重量	放流年月日	放流場所
39年	34.0㎜	39.0㎜	9.0㎜	4.2 g	40. 1. 2	伊達町字中鴨府
40	35.3	34.7	10.5	7.5	41. 2.10	〃 舟岡、鴨府
41	39.2	39.8	9.5	6.8	41.12. 3	〃 舟岡、鴨府、鉾

year
shell length
shell height
shell width
weight
release date
release location

1964
1965
1966

January 2, 1965
January 10, 1966
December 3, 1966

Date, Naka Mareppu
" , Funaoka, Mareppu
" , Funaoka, Mareppu, Kogane.

(Figure 10) Outline of the Scallop Fishing Grounds at Date

（第１０図） 伊達地先ホタテガイ漁場略図

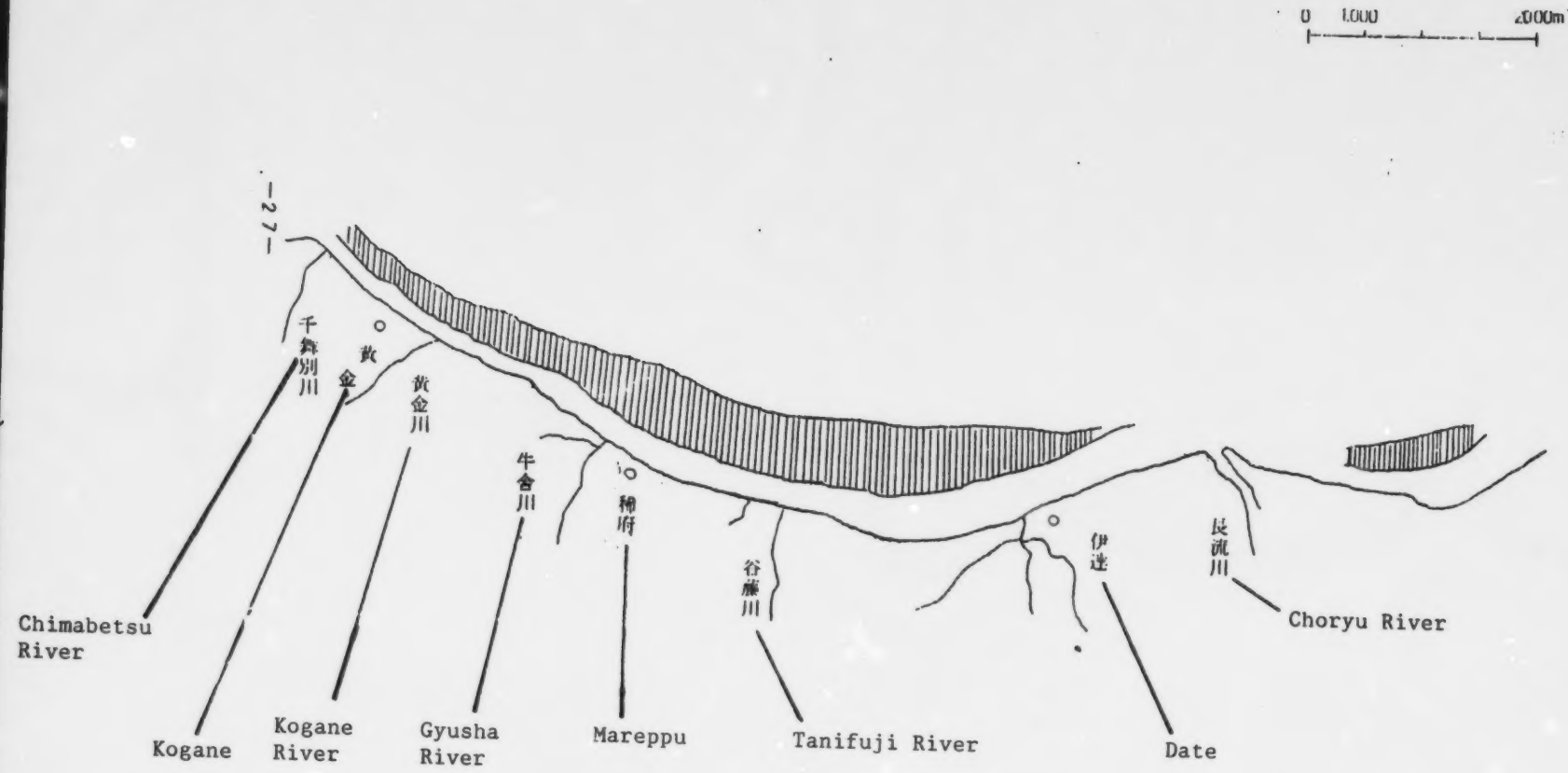


Figure 11 The Fishing Prohibited Area and the Investigation Locations

（第１１図） 禁漁区略図と調査箇所図

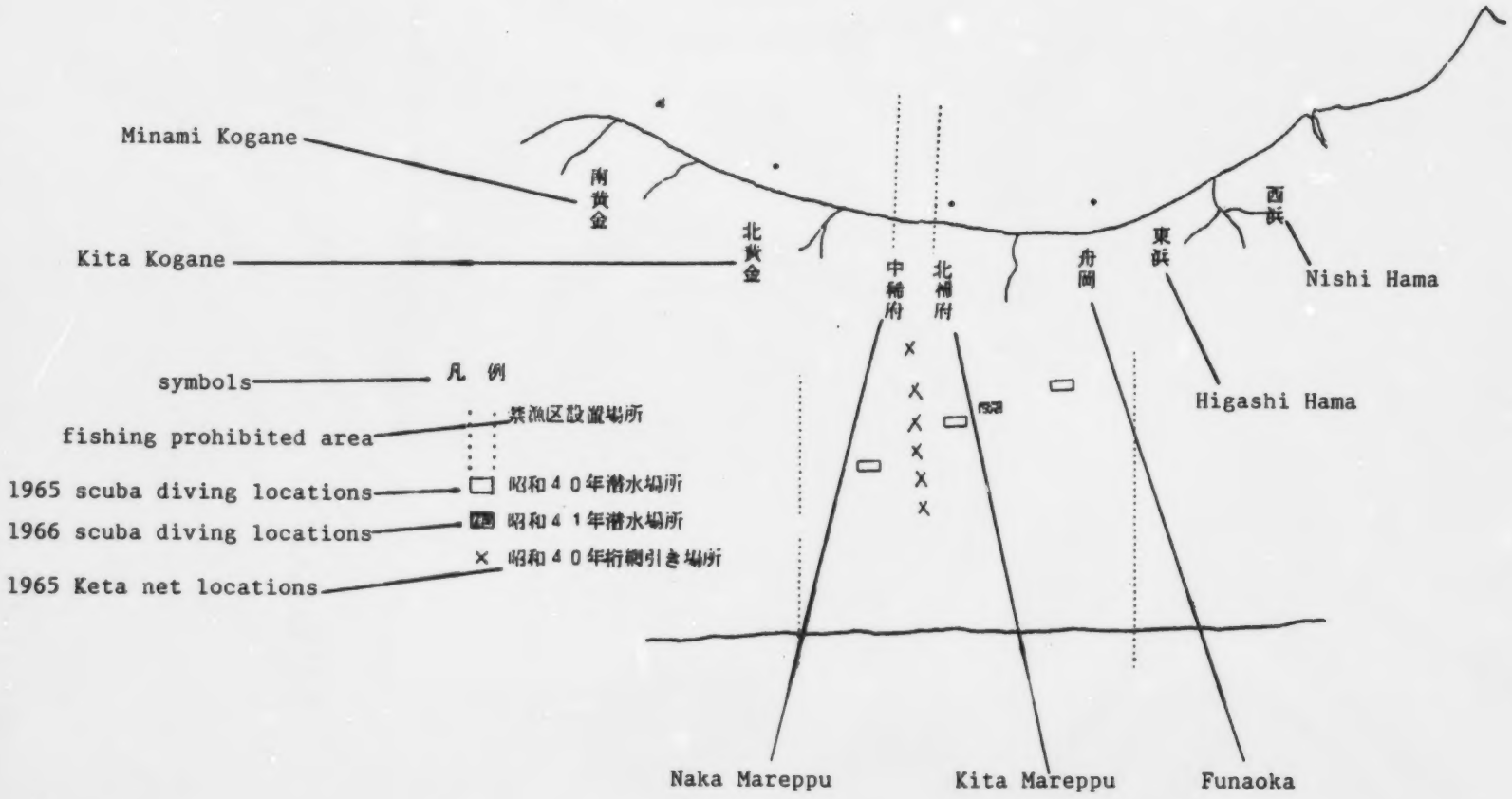


Table 11 Ages of the Scallops Collected by Scuba Diving

water depth | area m^2 | 1 year shells (released | natural) | 2 year shells (released | natural) | 3 year shells | 4 year shells and above | totals | notes | no 3-year shells

(第11表) スキューバーによる潜水採取ホタテガイ年令構成表

St	水深	面積 ㎡	1年貝 放流貝	1年貝 自然発生貝	2年貝 放流貝	2年貝 自然発生貝	3年貝	4年貝以上	合計	摘要
		㎡	ケ	ケ	ケ	ケ		ケ	ケ	
1	14.5	120	3			1	—	5	9	3年貝なし
2	14.5	300	52	4	4	4	—	15	79	
3	13.0	300	84	5	5	6	—	28	128	
計		720	139	9	9	11	—	48	217	

totals

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Table 12 Ages of the Scallops Collected by Keta Nets in 1965 (beam)

water depth | 1-year shells | 2-year shells | 3-year shells | 4-year shells and greater | Totals | Notes

(第12表) 1965年桁曳による採取ホタテガイ年令構成表

St	水深	1年貝	2年貝	3年貝	4年貝以上	合計	摘要
	m	ケ	ケ	ケ	ケ	ケ	
1	12.0				5	5	
2	13.0	1		3	5	9	
3	13.0	2		6	8	16	1ケ体放流貝 — 1 released shell
4	14.5	20	10	8	7	37	18ケ体放流貝 — 18 released shells
5	14.5	12		8	8	28	9ケ体放流貝 — 9 released shells
6	14.0				4	4	

Table 13 Growth Comparisons of the Released Shells (Fishing prohibited area)

test date　shell length　shell height　shell width　weight

(第13表)

放流貝の成長比較表 (禁漁区)

調査年月日	殻長	殻高	殻巾	重量
	cm	cm	cm	g
40. 9. 22	8.6	8.4	2.3	8.0
41. 9. 13	13.45	12.59	3.35	23.70

September 22, 1965　September 13, 1966

Table 14 Ages of the Scallops Collected by Scuba Diving

water depth　area m^2　1-year shells　2-year shells (released shells / natural shells)　3-year shells (released shells / natural shells)

(第14表)　スキューバーによる潜水採取ホタテガイ年令別成長

ST	水深	面積㎡	1年貝	2年貝 放流貝	2年貝 自然発生貝	3年貝 放流貝	3年貝 自然発生貝	4年貝	5年貝以上	合計	摘要良
A	14.5m	300㎡	4ケ	57ケ	—	ケ	8ケ	10ケ	25ケ	104ケ	3年貝の放流なし

total　notes　no 3-year shell releases

4-year shells　5-year shells and above

Recapture Investigation of the Releases Shells

operational fishing grounds — yield number — Kg of yield — %(No.) — shell length — shell height — shell width — weight

Table 15 (第15表) 放流貝の再捕調査表

operational period

操業期間	操業漁場	漁獲ケ数	漁獲K数	%(ケ体)	殻長	殻高	殻巾	重量
		ケ	Kg		cm	cm	cm	g
12月4日～2月10日	東西漁場	8,275	2,465.9	32.08	13.69	13.40	3.41	298.0
2月13日～3月 5日	禁漁区	15,588	5,446.4	67.92	14.61	14.02	3.63	349.38
合計及び平均		23,863	7,912.3	100%	14.15	13.71	3.82	323.69

December 4 - Febr. 10 — east-west

February 13 - March 5 — fishing prohibited area

totals & averages

Growth Investigation for each Storage Number

number stored — shell length — shell height — shell width — weight

Table 16 (第16表) 収容密度別における成長調査表

investigation date

調査月日	収容ケ体数	殻長	殻高	殻巾	重量
6月13日	10	6.70cm	6.50cm	1.52cm	32 g
	15	5.35	5.35	1.35	25
	20	5.10	4.92	1.32	24
	25	5.28	5.25	1.42	25
average	平均	5.67	5.50	1.40	26.5
8月1日	10	7.42	7.20	1.87	45
	15	7.10	6.76	1.78	42
	20	6.68	6.36	1.72	30
	25	6.30	6.02	1.65	28
average	平均	6.82	6.58	1.75	36.5
9月25日	10	9.00	8.50	2.30	69
	15	8.10	7.90	2.10	60
	20	7.50	7.70	2.00	55
	25	7.10	6.80	2.10	42
average	平均	7.92	7.75	2.15	56.5

June 13

August 1

September 25

Figure 12 Seedling Collection-Rearing Facility Locations at Usu, Date

A, location of baskets with film seedling collectors

B, location of vertical rearing apparatuses

C, fishing grounds for transfer and releases

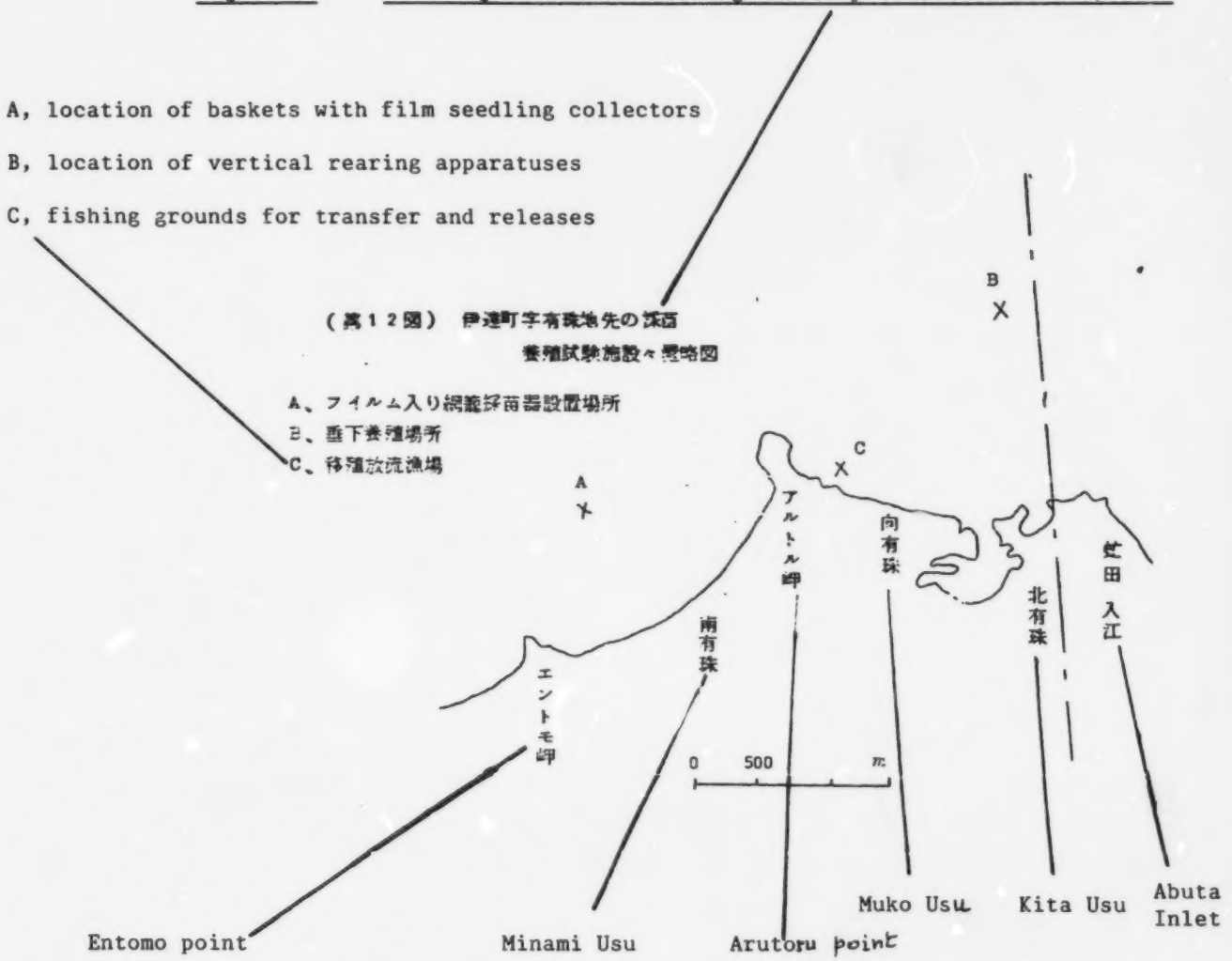


Table 17-1 (A) The Investigated Results for the Vertically Reared Scallop Growth at Higashi-Hama, Date

rearing apparatus — investigation date — shell length — shell height — shell width — weight including shell — fresh weight — eyes of scallop weight — notes

（第１７表～１）

(A) 伊達町字東浜神合い垂下養殖ホタテガイ成長度調査表

育成器種別	調査年月日	殻長	殻高	殻巾	殻付重	肉重量	貝柱重量	摘　要
		cm	cm	cm	g	g	g	
box type 箱型 30×30×15	39. 8.25	1.10	1.20	0.2	0.8			育成場所有効湾口
andon (cylindrical) アンドン型 〃	39. 9.20	1.75	1.82	0.4	1.3			〃
〃	39.10. 8	2.45	2.45	0.5	3.6			〃
andon type アンドン型 ∮50cm	39.11.10	3.40	3.90	0.9	5.2			〃
〃	39.12.20	4.05	4.15	1.0	8.0			〃
〃	40. 3.18	4.55	4.85	1.05	9.5			〃
multi-layered 多段式 ∮38cm	40. 6.15	5.61	5.51	1.40	26.5			〃 東浜神合い
〃	40. 8. 1	6.82	6.58	1.75	36.2			〃
〃	40. 9.25	7.92	7.75	2.15	56.5			〃
multi-layered 多段式 ∮55cm	40.12.21	9.80	9.70	2.90	105.0	41.0		〃
〃	41. 3.31	10.90	10.60	3.40	192.0	84.0		〃
〃	41. 5.25	11.20	10.60	3.30	181.0	76.0		〃
〃	41. 9.18	13.20	12.90	3.70	285.5	126.5	49.8	〃
〃	41.12.13	13.71	13.12	3.95	3[illegible]7.8	145.5	53.8	〃

notes: rearing location - north of Usu Bay; rearing location- Higashi-Hama

39 = 1964
40 = 1965
41 = 1966

month designated by ordinal / same for day

和40~41年度ホタテガイ垂下養殖試験施設図 — Diagram of the 1965-1966 Vertical Scallop Rearing Test Facility

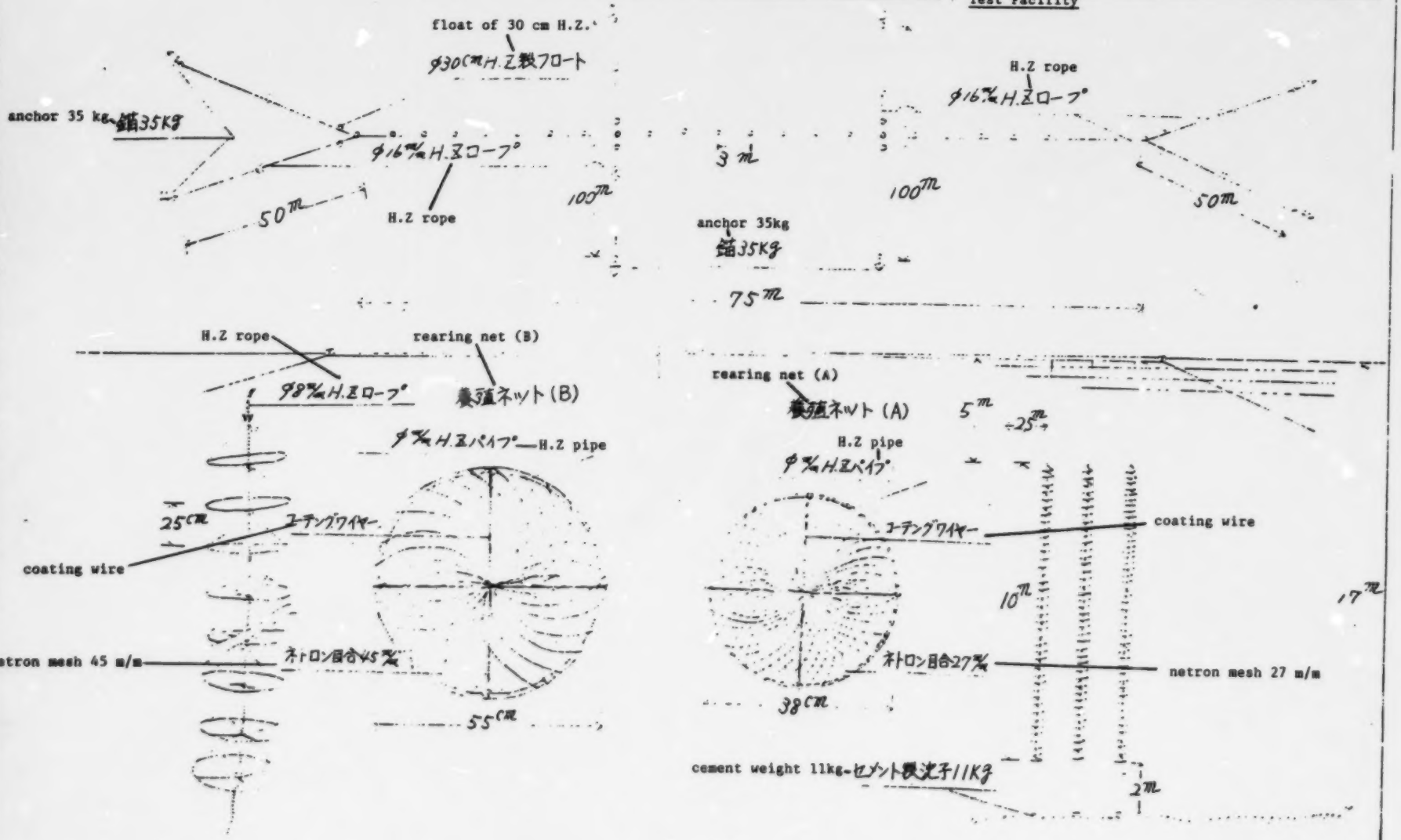
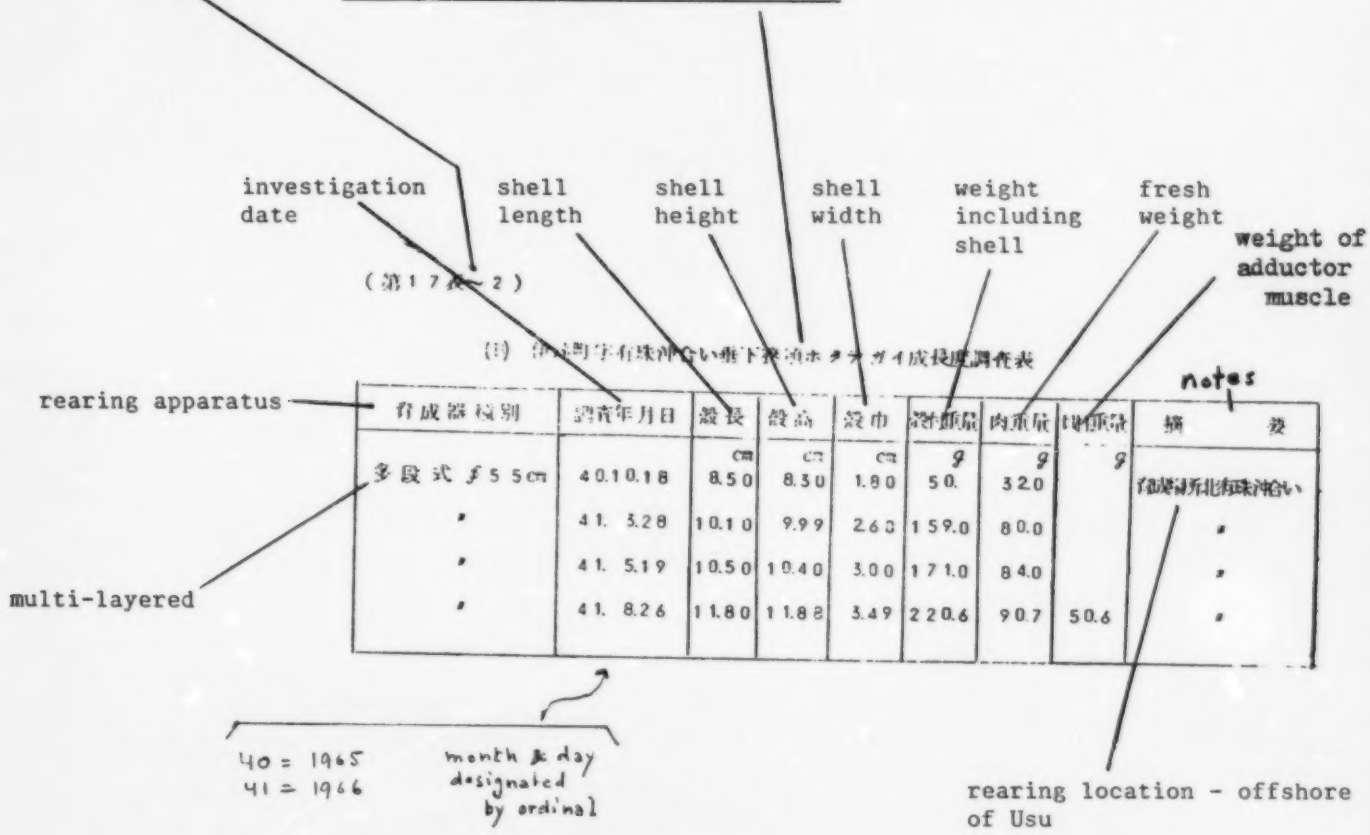


Table 17-2 (B) The Investigated Results for the Vertical Scallop Rearing Growth at the offshore of Usu, Date



(第17表－2)

(B) 宇和島宇和津湾沖垂下養殖ホタテガイ成長度調査表

育成器種別	調査年月日	殻長	殻高	殻巾	全重量	肉重量	閉殻筋重量	摘要
		cm	cm	cm	g	g	g	
多段式 ∮55cm	40.10.18	8.50	8.30	1.90	50.	32.0		宇和津北海沖合い
〃	41. 3.28	10.10	9.99	2.60	159.0	80.0		〃
〃	41. 5.19	10.50	10.40	3.00	171.0	84.0		〃
〃	41. 8.26	11.80	11.88	3.49	220.6	90.7	50.6	〃

(Table 18-1) Investigated Results of the Growth of Vertically Reared Scallops

(A) Investigated at the Higashi-Hama Offshore, Date December 13, 1966

shell length — shell height — shell width — weight including shells — fresh weight — weight of adductor muscle — Notes

(第18表～1)

垂下式垣ホタテガイ成長調査表 (A) 伊達町東浜沖合い～調査 41. 12. 13

番号	殻長 cm	殻高 cm	殻巾 cm	総体重量 g	肉重量 g	貝柱重量 g	備考
1	13.20	12.50	4.30	365	173	51	ムラサキイガイ付着
2	14.60	13.00	3.65	338	163	52	〃
3	13.00	12.40	3.60	270	130	50	〃
4	13.80	13.30	4.20	360	150	52	〃
5	13.80	12.70	4.00	345	155	54	ヒダベリ、イソギンチャク
6	13.40	12.50	3.90	320	160	55	〃 散付着
7	13.20	12.50	4.50	320	160	54	〃
8	14.65	14.45	3.70	360	180	55	オオイワフジツボ付着
9	14.15	14.00	3.95	390	172	52	〃
10	13.20	12.30	4.20	325	155	53	ヒダベリ、イソギンチャク
11	14.15	14.05	4.00	390	175	57	〃
12	14.30	14.50	4.50	423	250	70	〃
13	14.15	14.00	4.20	390	172	58	〃
14	13.35	13.25	4.05	320	160	55	〃
15	14.05	15.05	3.70	330	150	53	〃
16	13.90	12.90	4.10	350	175	56	〃
17	14.50	14.25	3.85	375	173	52	〃
18	14.15	14.00	3.95	390	173	53	〃
19	13.90	12.90	4.10	350	175	57	〃
20	14.30	14.50	4.50	423	250	68	〃
21	13.35	13.25	4.05	330	160	51	〃
22	13.00	12.50	3.90	360	150	52	〃
23	14.60	13.00	3.65	338	163	52	〃
24	14.30	14.00	3.90	370	173	53	〃
25	13.80	12.80	4.00	385	152	51	〃
26	14.50	14.25	3.85	375	173	54	〃
27	13.90	12.90	4.10	350	175	55	〃
28	14.30	14.00	3.90	330	160	51	〃
29	13.20	12.30	4.20	325	155	50	〃
30	13.40	13.10	4.30	385	175	55	オオイワフジツボ付着
31	14.00	13.00	3.75	320	150	51	〃
32	13.90	12.95	4.05	340	170	55	〃
33	13.20	12.30	4.05	325	160	54	〃
34	13.20	12.30	3.60	290	142	50	〃 散付着
35	13.00	12.50	3.90	350	155	51	〃
36	13.80	13.30	4.10	355	160	53	〃
37	12.90	12.55	4.00	310	145	52	〃
38	12.80	12.30	3.85	300	150	50	〃
39	12.70	12.40	3.95	350	152	47	〃
40	12.80	12.30	3.85	300	150	48	〃
平均	13.71	13.12	3.99	347.8	145.5	53.8	肉重量 41.8%

average

Notes:
- ムラサキイガイ付着 — blue mussels attached
- ヒダベリ、イソギンチャク — hidaberi, sea anemone
- 散付着 — sporadically attached
- オオイワフジツボ付着 — ooiwa barnacles attached
- ヒダベリ、イソギンチャク — hidaberi, sea anemone
- オオイワフジツボ付着 — ooiwa barnacles attached
- 散付着 — sporadically attached
- 肉重量 41.8% — fresh weight 41.8%

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(Table 18-2) Investigated Results of the Growth of Vertically rEared Scallops

(B) Investigated at the Kita-Usu Offshre, Date, August 26, 1966

shell length

shell height

shell width

weight including shells

fresh weight

weight of adductor muscle

notes

adductor muscle

height

adductor muscle

average

(第18表～2)

垂下養殖ホタテガイ成長調査表　(B) 伊達町北有珠沖合い～41. 8. 26

No.	殻長 cm	殻高 cm	殻巾 cm	殻付重量 g	肉重量 g	貝柱重量 g	摘要
1	12.80	12.20	3.40	215	95	50	
2	13.20	12.90	3.60	245	92	45	貝柱～ϕ4.50 高 25 5
3	12.80	12.60	3.40	240	94	56	
4	12.00	12.00	3.50	212	95	52	
5	11.30	11.20	3.60	200	80	48	
6	12.70	11.70	3.50	220	92	52	
7	13.00	12.50	3.90	250	100	60	
8	12.00	12.00	3.70	240	95	58	貝柱～ϕ5.1 高 2.90
9	11.50	11.00	3.20	180	78	47	
10	12.90	12.30	3.50	230	94	52	貝柱～ϕ5.4 高 2.7
11	12.60	11.90	3.20	208	84	48	
12	12.80	12.30	3.50	230	90	50	
13	12.40	12.40	3.90	235	94	55	貝柱～ϕ5.1 高 2.65
14	13.20	12.00	3.40	217	94	51	
15	12.00	11.70	3.50	212	92	50	
16	12.90	12.30	3.80	280	114	63	貝柱～ϕ5.6 高 2.55
17	12.70	12.20	3.60	240	96	57	
18	11.00	11.00	3.40	170	72	36	
19	11.80	11.55	3.50	190	80	49	
20	13.00	12.50	3.65	235	110	52	貝柱～ϕ5.5 高 2.45
21	11.40	11.55	3.50	200	80	49	
22	13.25	12.60	3.75	258	100	52	貝柱～ϕ5.4 高 2.1
23	11.40	10.85	3.10	170	76	46	
24	12.15	11.60	3.60	280	112	63	
25	13.40	12.70	3.70	270	100	50	貝柱～ϕ5.3 高 24
26	12.40	12.60	3.40	230	95	55	
27	12.70	12.40	3.50	215	86	50	
28	12.85	12.40	3.55	240	95	47	
29	11.70	11.25	3.20	175	70	36	貝柱～ϕ5.1 高 1.95
30	12.45	11.95	3.50	205	80	50	
31	12.10	12.10	3.60	245	105	52	
32	12.20	11.55	3.40	190	80	48	
33	11.40	11.40	3.20	195	90	48	貝柱～ϕ5.2 高 2.20
34	11.00	11.05	3.00	170	78	48	
35	12.00	12.00	3.30	200	81	50	
36	12.70	12.30	3.65	250	110	53	貝柱～ϕ5.5 高 2.40
37	12.05	11.75	3.50	220	70	42	
38	11.90	11.40	3.40	198	85	45	
40	12.70	12.40	3.80	245	105	62	貝柱～ϕ5.65 高 2.6
平均	11.80	11.86	3.49	220.6	90.7	50.6	ϕ5.28 高 2.46

(Table 19)

Water Quality Analysis Table

analysis date

water depth

silicates

phosphates

nitrates

nitrites

ammonium salts

(第19表)

水　質　分　析　表

Notes

分析月日	水　深	ケイ酸塩 SiO_2	リン酸塩 P_2O_5	硝酸塩 NO_3-N	亜硝酸塩 NO_2-N	アンモニウム塩 NH_4-N	摘　要
July 1 — 7月1日	3.0m	0.38	0.0092	0.0214	0.0004	0.064	採取場所 — collection location
	8.0	0.40	0.0073	0.0243	0.0003	0.030	水深17m地点 — at a water depth of 17 m
	10.0	0.60	0.0101	0.0212	0.0002	0.042	伊達町字東浜地先 — at Higashi-Hama, Date
	15.0	0.72	0.0174	0.0321	0.0003	0.048	単位～PPm — units - PPm
February 4 — 2月4日	3.0m	1.22	0.0392	0.0231	0.0017	0.260	
	8.0	0.86	0.0112	0.0302	0.0006	0.012	同　上 — same as above
	10.0	0.72	0.0090	0.0285	0.0005	0.008	
	15.0	0.62	0.0100	0.0335	0.0005	0.008	

(Table 20)

Growth Comparisons of the Released Shells and the Vertically Reared Shells

vertical rearing fishing grounds and release fishing grounds

investigation date

shell length

shell height

shell width

weight including shell

flesh weight

adductor muscle weight

（第２０表）

放流貝と垂下養殖貝の成長比較表

垂下養殖場と放流漁場	調査月日	殻長	殻高	殻巾	殻付重量	肉重量	貝柱重量	摘　　要
垂下養殖場(A)	41. 9. 18	13.20	12.90	3.70	285.5	126.5	49.8	
中茂尻先(放流区)	41. 9. 15	13.45	12.59	3.35	237.0	115.5	42.0	砂質、バラス、死貝殻
垂下養殖場(B)	41. 8. 26	11.80	11.88	3.49	220.6	90.7	50.6	
有珠地先漁場	41. 9. 3	10.74	10.54	2.66	135.0	52.0	25.0	水深4.5～6mの底にスガモ部分密生

rearing fishing grounds (A)

Naka Mareppu (fishing prohibited area)

rearing fishing grounds (B)

Usu fishing grounds

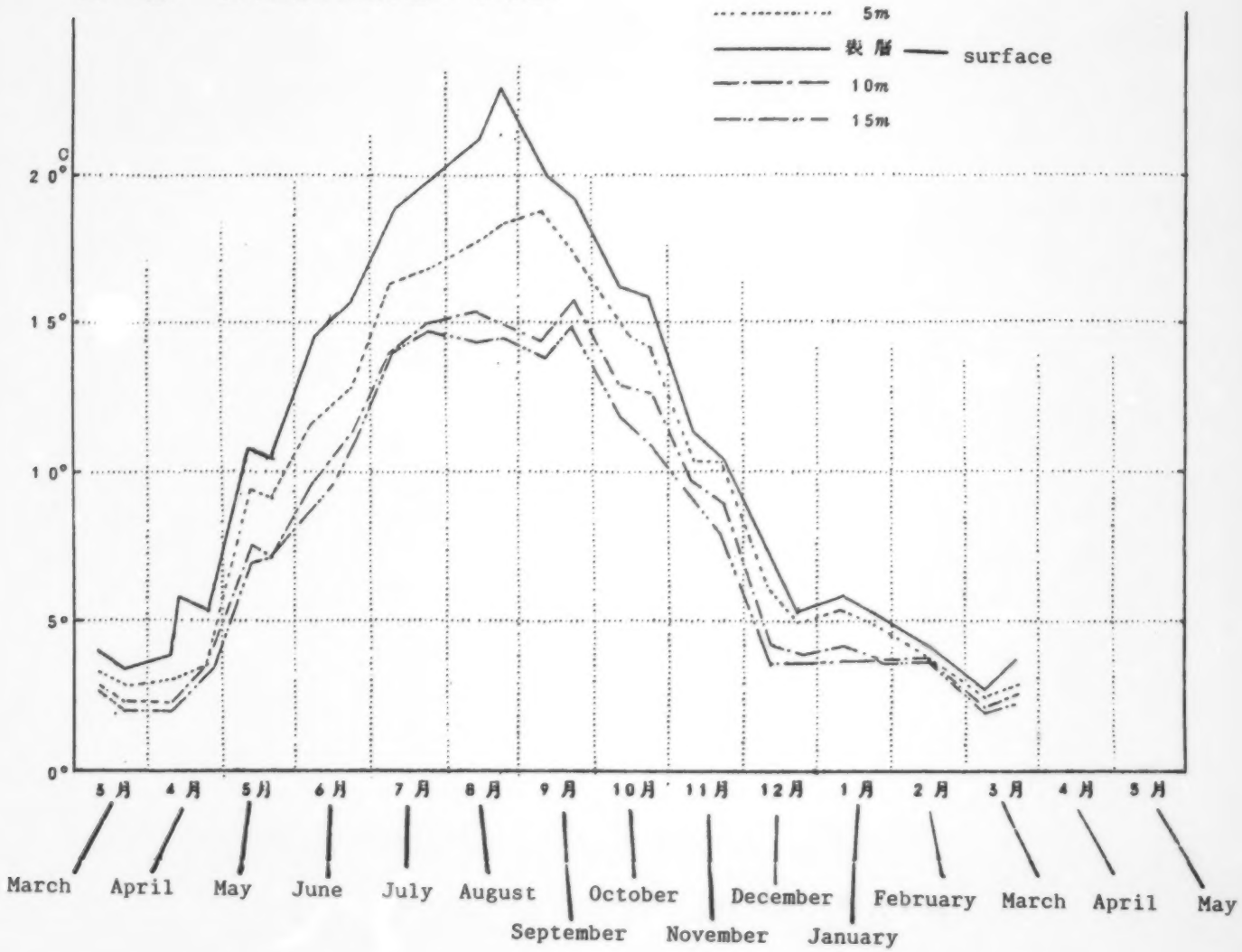
notes

sandy, gravel, dead shells

water depth 4.5-6m sandy with partly covered sugamo

(Figure 14) Water Temperatures for each Water Depth at the Rearing Fishing Grounds (A Fishing Grounds)

(第14図) 蓄殖漁場水深別水温表 (A漁場)



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The 1960 Investigated Results of the Growth of the Vertically Reared Scallops

(Origasa, Yamada, Shimo-Hei -gun, Iwate Prefecture)

month and date　　water temperature　　shell length

(Table 21)　(第21表)

昭和35年垂下養殖ホタテガイ成長調査表

(岩手県下閉伊郡山田町笠地　)

月　日	水　温	殻　長
5月 3	6℃	4.0cm
5・10	10	5.0
5・25	12	5.6
6・ 5	14	7.0
6・15	14	7.5
6・25	13	8.0
7・ 5	18	9.0
7・25	20	9.5
8・ 5	22	10.0
8・25	22	10.5
9・10	19	10.9
9・30	19	11.0
10・10	19	11.5
10・25	15	11.5
11・10	12	12.0
11・24	12	12.5
12・10	9	13.0
12・20	7	13.5

11. Reference Materials p.45

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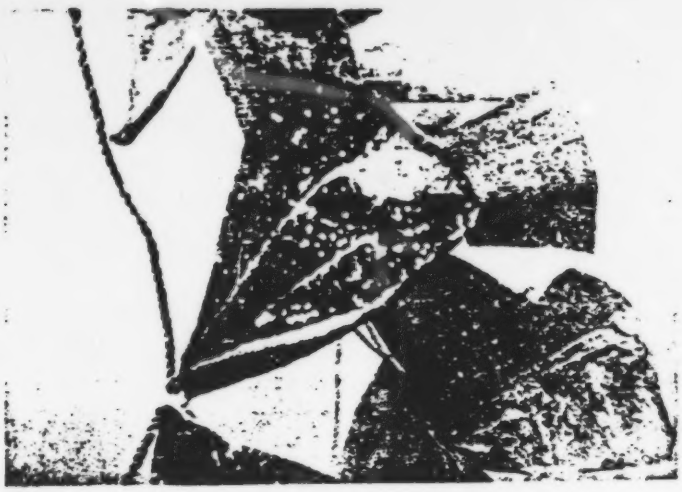
12. Explanation of Photographs

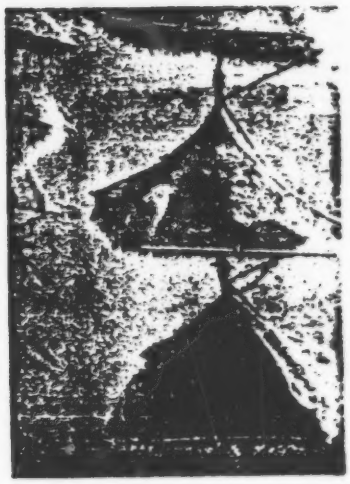


水深14mのポリエチレン、フィルムに附着しているホタテガイ稚貝

Young scallop shells attached to polyethylene film at a water depth of 14 m.

水深14.5mに垂下のお盆型採苗兼育成器に附着しているホタテガイ稚貝

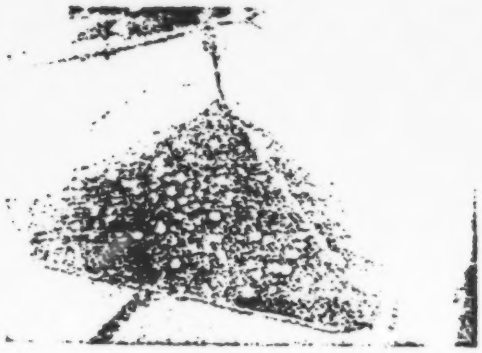
Young scallop shells attached to a vertical tray-type collector-rearer at a water depth of 14.5 m.



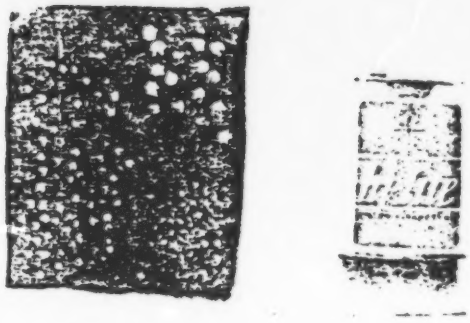
水深10mにおけるフィルム入り網籠採苗器の垂下状態

Vertical condition for the basket-type collectors with film at a water depth of 10 m.

p.48



水深14.5mにおけるフイルム入り籠型採苗器のホタテガイ稚貝の付着状態



昭和41年7月25日調査の附着稚貝区分

The attachment conditions of the young scallop shells on a basket-type collector with film at a water depth of 14.5 m.

categorized attached shells from the July25, 1966 investigation.

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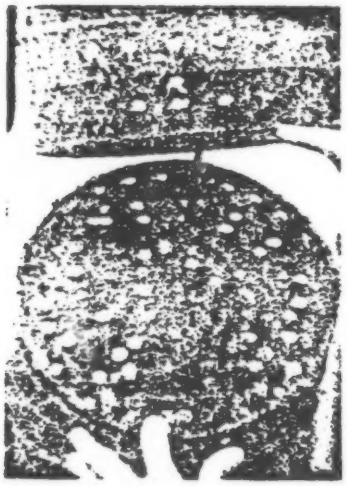
For information only
TRADUCTION NON REVISÉE
Information seulement

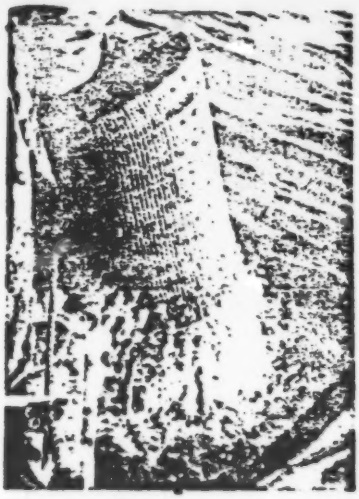


稚貝採苗兼育成器に侵入しているヒトデ（このヒトデの大きさまでに除去が必要）

昭和39年度に試験を行なつたお盆採苗兼育成器の稚貝成長状態（　月　日）

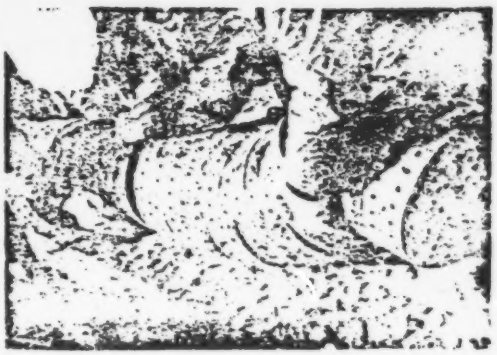
Starfish which have invaded a tray-type seedling collector-rearing apparatus (they must be removed before the starfish reach this size)

Status of the young shell growth in a tray-type collecting-rearing apparatus investigated in 1964 (month day)



ラッセル網で包んだお盆採苗兼育成器を引き揚げるところ

A tray-type seedling collector- rearing apparatus wrapped with a Russell net being pulled up.

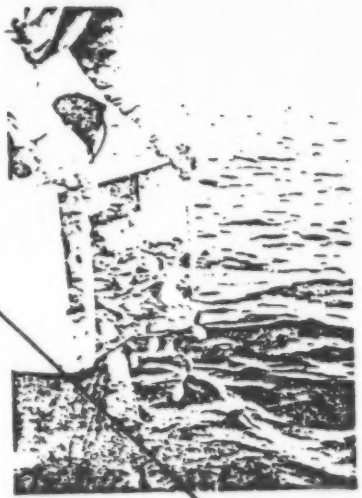


お盆採苗兼育成器から稚貝採取
（昭和41年12月13日）

Collecting young shells from a tray-type seedling collector-rearing apparatus (December 13, 1966)

p.49

種苗の大きさ
size of the seedlings



種苗の放流

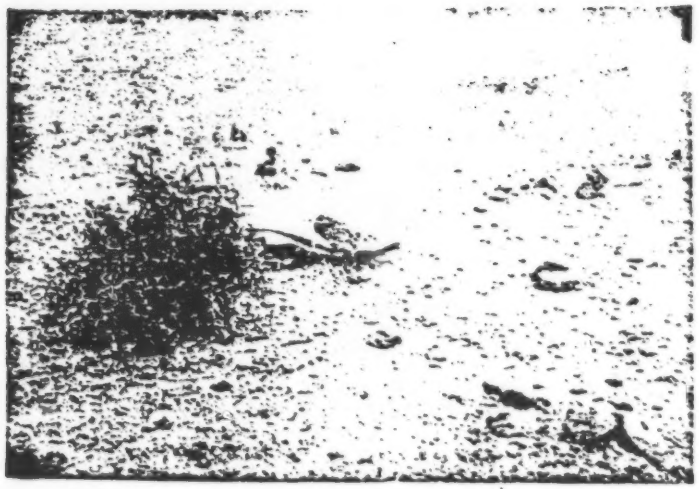
The release of seedlings.

Released Shells
December 13, 1966 (DATE)

「バラス場」に生息している5年貝のホタテガイ
（昭和40年9月、禁漁区、水深14.5m）

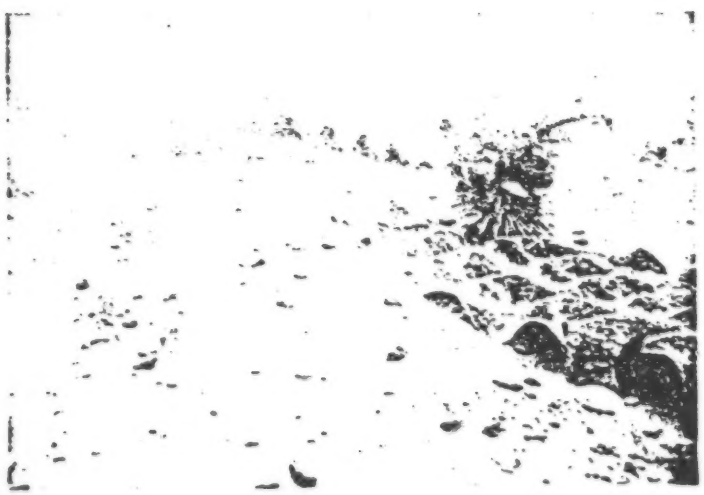
5-year old scallops living in gravel ground (September 1965, fishing prohibited area, water depth of 14.5 m)

p.50



石殻を上に棲息している6年貝のホタテガイ（昭和40年9月、禁漁区水深145m）

6-year scallops with right shells on top (September 1965, fishing-prohibited area, water depth of 14.5 m)

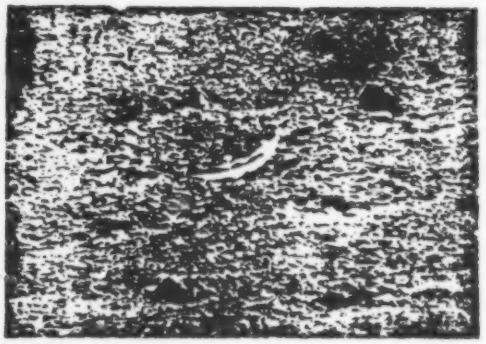


伊達地先のホタテガイ漁場に多くなられる海底（昭和40年9月、禁漁区、水深15m、中央に放流貝がみられる）

Much of the sea bottom appears like this at the scallop fishing grounds at Date (September 1965, fishing-prohibited area, water depth of 15 m, released shells are seen at the center)

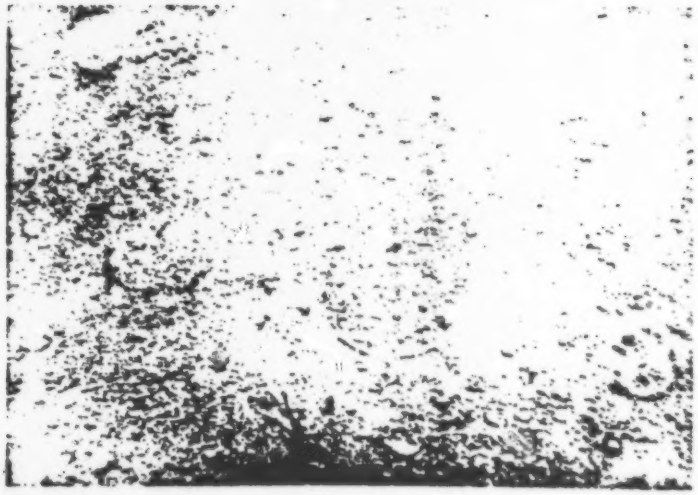
放流貝（一年貝）が移動したあとにできる。棲息跡の穴が右下に数箇所みられる。中央は放流貝である。（昭和四十年九月、禁漁区、水深14.5 m）

Several habitation holes left behind after the released shells (1-year shells) migrated can be seen in the lower right section. (September 1965, fishing-prohibited area, water depth of 14.5 m)



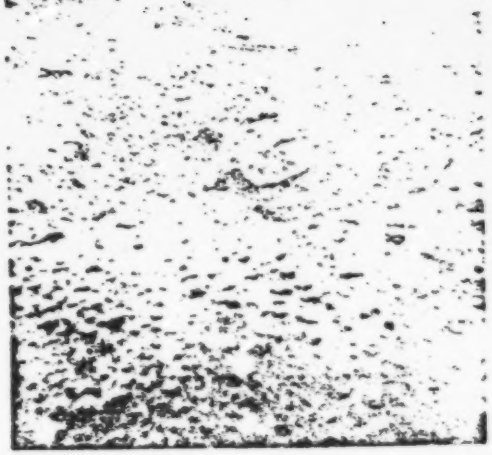
放流貝の棲息状態（昭和四十三年九月、禁漁区水深14.5 m）

Habitation conditions of the released shells (September 1965, fishing-prohibited area, water depth of 14.5 m)



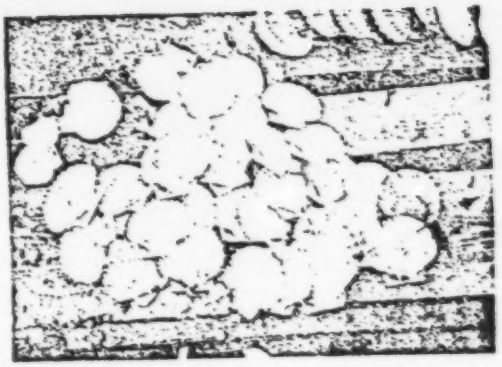
禁漁区設定から二年経過の泥化した海底と放流貝（昭和四十一年九月、水深14.5 m）

Muddy sea bottom 2 years after the fishing-prohibited area was set up and the shells released (September 1965, water depth of 14.5 m)



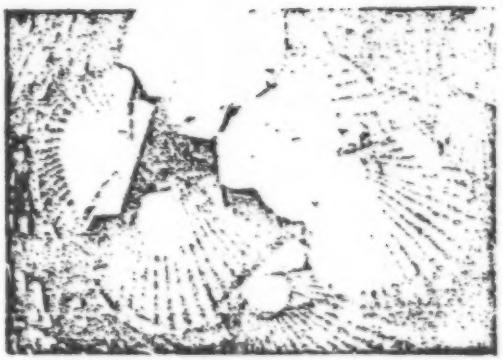
開閉運動によつてみられる放流貝の棲息状態
（昭和４１年９月、禁漁区水深14.5m）

Habitation conditions of the released shells as seen in their opening-closing movements (September 1966, fishing-prohibited area, water depth of 14.5 m)



昭和４１年９月７日、禁漁区より東側漁場へ
１００m、水深１５０mでケタ網２台により採
取された放流貝

Released shells collected with 2 keta nets at a fishing ground location 100 m east of the fishing prohibited area on September 7, 1966.

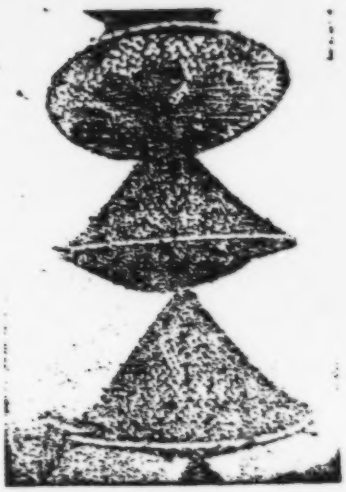


禁漁区より再捕された放流貝
（昭和４２年２月）

Recaptured released shells from the fishing prohibited area (February 1967)

成長輪が明瞭に表われている放流貝
（再捕、昭和４１年８月）

Released shells with prominent damage rings (recaptured in August 1966)



多段式育成器による養殖用種苗の育成状態
（昭和40年8月、水深10m、15個収容のもの）

The growth condition (status) of the seedlings in a multi-layered rearing apparatus (August 1965, water depth of 10 m, 15 shells stored)

August 26, 1966

vertically reared shells

released shells

垂下養殖貝と放流貝

Vertically reared shells and released shells

多段式育成器（本養成）の上段にみられた珪藻類附着の状態
（垂下後約一年経過、水深7～8m。昭和41年8月記録）

The diatoms attachments observed in the upper layers of the multi-layered rearing apparatus (actual rearing) (one year after lowering, water depth 7-8 m. Recorded August 1966)

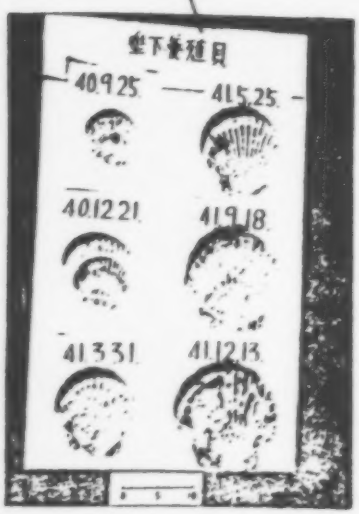
多段式育成器（本養成）の垂下状態
（育成器を交換して、2度目のもの、昭和41年5月25日垂下、9月18日記録。水深10m～12.5m）

Vertical condition of the multi-layered rearing apparatus (for actual rearing) (rearing apparatus was exchanged, this is the 2nd one, lowered on on May 25, 1966, recorded on September 18. Water depth 10m-12.5m)

多段式育成器（本養成）の養殖貝（約80%が右殻下向き、水深10～12m 昭和41年9月記録）

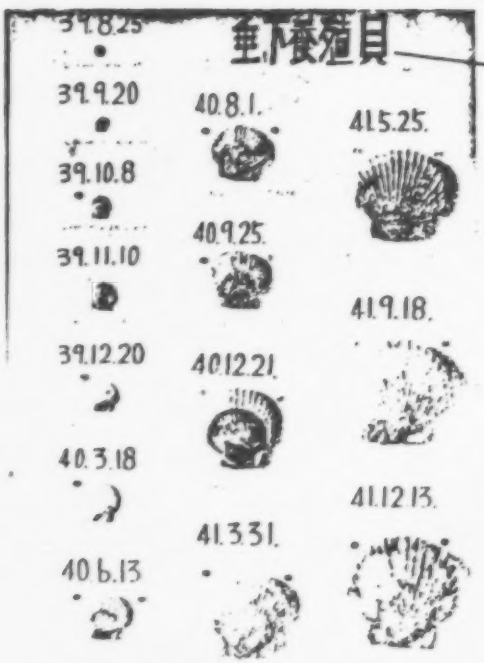
Reared shells of the multi-layered rearing apparatus (actual rearing) (about 80% of the have their right shells facing down, water depth of 10-12 m, recorded September 1966).

vertically reared shells



本養成での養殖貝
（田ノ浦下中ノ島漁場で養殖したもの）

Reared shells from the actual rearing growth (reared at the Higashi Hama fishing grounds, Date)



vertically reared shells

Growth conditions from mid-rearing to the actual rearing growth.